JPL PUBLICATION 81-66, VOLUME I

Total-Dose Radiation Effects Data for Semiconductor Devices

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National Aeronautics and
Space Administration

Jet Propulsion Laboratory
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ABSTRACT

This document provides steady-state, total-dose radiation test data, in graphic format, for use by electronic designers and other personnel using semiconductor devices in a radiation environment. The data were generated by JPL for various NASA space programs. The document is in two volumes. Volume I provides data on diodes, bipolar transistors, field effect transistors, and miscellaneous semiconductor types. Volume II provides data on integrated circuits.

INDEX OF DEVICE TYPES

VOLUME I

[a]See Appendix A for Vendor Identification Code.

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SECTION I

INTRODUCTION

The data presented in Volumes I and II of this report describe the results of Total Ionizing Dose (TID) tests of semiconductor devices (Volume I) and integrated circuits (Volume II). The data were obtained by the Jet Propulsion Laboratory (JPL), under contract to NASA, in order to assure the "hardness" (radiation resistance) of components to be used in the Jupiter radiation environment. However, the data is applicable to any ionizing radiation environment. Two primary radiation sources were used: a Cobalt-60 gamma ray source and a Dynamitron capable of delivering 2.5 MeV electrons at a steady rate. The Cobalt-60 source was used when it was determined that bulk radiation damage was negligible (NPN transistors, FETs) or when the electron source was incapable of penetrating the package (power transistors).[1] The Dynamitron was used for PNP transistors and ICs. Irradiations of complex ICs were subcontracted to the Boeing Radiation Effects Lab (BREL), Seattle, Washington, where the necessary computerized test equipment was available. The work at BREL was subject to specifications and procedures under the direction of JPL.

In Volume I, the data are presented in a graphic format for various operating conditions as a function of dose. Some measure of the statistical variations of each device lot is provided by the tabulated standard deviations and statement of sample size. Irradiations of two or more different lots of a given device type are treated as entirely separate tests.

In Volume II, the information on some of the integrated circuits is presented in tabular format. For more complex LSI devices, the data are given in a narrative form, which gives proper emphasis to the radiation-induced changes in the measured parameters.

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[1] A program has recently been initiated at JPL to compare the response of power transistors with Cobalt-60 and electron irradiation where the transistors have been packaged in a TO-5 can. A report will be published in late 1981.

All data taken here substantially meet the specifications of MIL-STD-883B, method 1019.1 (August 1977) for environments where short-term annealing is not a relevant problem. Electrical parameter measurements were usually taken within 20 minutes of the completion of an irradiation, for three or more radiation levels, at room temperature, with a sustained worst-case bias during irradiation for JPL's systems applications.

SECTION II

DOCUMENT USES AND LIMITATIONS

The purpose of this report is to provide a large amount of test data for semiconductor devices exposed to a steady-state TID irradiation. As such, it offers a useful comparison of the radiation response of different devices that might be considered in the development (circuit design) of a radiation-hardened system. It also offers a quick method for assisting an engineer to determine the weak links in an existing system and the maximum radiation tolerance of the system as a whole.

The data presented here cannot, in any way, be used as a substitute for a comprehensive testing program of the devices actually used in a given system. It will be clear, on inspecting the data herein, that there are large lot-to-lot or wafer-to-wafer variations in the response of samples of a given device type. The difference in response from functionally identical devices fabricated by different manufacturers is, of course, much greater. There was no attempt to remove maverick (outlier) devices from the data plots. Thus, some of the data plots may appear anomalous when compared to other plots for that same device type. Finally, there is always the likelihood that a given manufacturer will make a minor adjustment in his processing procedures that will result in a major difference in the device's response to radiation.

SECTION III

GENERIC DEVICE TYPE INFORMATION

Some generalized comments appropriate to each generic device type are provided in the following subsections. A description of the vendor identification codes is provided in Appendix A. The mean of the electrical parameters measured for each generic device type is given on the ordinate of the graphs. A detailed description of these parameters is provided in Appendix B.

A. DIODES

Radiation tests of diodes have been very limited for space programs because of the inherent radiation hardness at the total worst-case dose levels of 3000 Gy(Si) [1 Gray (Gy) = 100 rads]. Testing may be required for special high-precision applications or for higher total-dose environments where very large (orders of magnitude) increases in the leakage current can be expected.

B. BIPOLAR TRANSISTORS

For convenience, the degradation in transistor gain (h_{FE}) is plotted as $\Delta(1/h_{FE}) = 1/h_{FE\phi} - 1/h_{FEo}$, where $h_{FE\phi}$ is the value at the specified radiation level, and h_{FEo} is the initial value. Implicit in this approach is the assumption that the radiation behavior can be approximated by the well-known formula:

$$\Delta(1/h_{FE}) = K\phi$$

where ϕ is the dose (or fluence) and K is a damage constant that depends on the device and on the collector current, I_C.

C. FIELD EFFECT TRANSISTORS (FETs)

FETs are not affected by bulk damage since they are majority carrier devices. Hence, most measurements were taken following Cobalt-60 irradiation. The key parameters plotted as a function of dose include I_{GGS}, I_{DSS}, V_{GS}, transconductance, noise voltage, and I_D (off). (See Appendix B.)

D. SILICON-CONTROLLED RECTIFIERS (SCRs)

Because of the limited use, the SCR type of device was tested to limited special requirements.

E. OPTICAL DEVICES

The optical devices consist of light-emitting diodes, phototransistors, and optical isolators.

SECTION IV

RADIATION SOURCES AND DOSIMETRY

A. DYNAMITRON

The Dynamitron accelerators at JPL and BREL provide a 2.5-MeV beam with a range of beam currents of 10^8 to 10^{10} electrons/cm^2/sec. All tests described here were irradiated at each level at exposure times between 5 and 45 minutes.

The parts test geometry for the two Dynamitrons is essentially the same. The electron beam is brought out of the beam tube into air through a 0.05-mm titanium window, copper and aluminum scattering foils, and 0.9 m of air. Each of these materials scatters the electrons slightly so that the beam has a reasonable uniformity of less than 20 percent over the array of parts being tested. The array is confined within a 25-cm diameter circle perpendicular to the direction of the beam. At the center of the circle is the aperture of a vacuum Faraday cup, which is used to control the flux and fluence of the electron beam. The beam is centered on the Faraday cup with a quadrupole magnet prior to the installation of the test samples. The output from the Faraday cup is a current that is fed into a current integrator, which is calibrated daily with a calibrated current source. The integrator is set to shut off the electron beam automatically when the desired fluence level is received by the Faraday cup.

B. COBALT-60 SOURCES

The Cobalt-60 gamma ray sources at JPL and BREL were both used. The gamma rays consisted primarily of 1.17 and 1.33 MeV photons with a consistent spectrum of lower energy photons and secondary electrons arising from scattering and absorption. The gamma field was uniform within ±10 percent in the area where parts were exposed. Thermoluminescent dosimetry (TLD), consisting

of lithium fluoride/Teflon microrods, was used for uniformity checks. Calibration of the main source was performed with Landsverk ion chambers of ±2 percent accuracy, traceable to the National Bureau of Standards. Monthly dose rate computations were performed to account for the decay of the Cobalt source. Exposure times with the Cobalt-60 sources were typically 5 to 20 minutes for each radiation level. Longer times (up to 4 hours) were required for high-dose applications since the maximum uniform dose rate available was 150 Gy/min.

SECTION V

TEST SETUP AND PROCEDURES

A. GENERAL REMARKS

The test setup and procedures used here were developed in accord with the specifications of MIL-STD-883B (August 1977), method 1019.1. All tests were done at 25°C ±3°C, using low noise power sources and instrumentation subject to periodic calibration. Some tests were performed in situ (without removing the test devices from the radiation area), whereas others required remote testing. In the latter event, a mobile bias fixture was used to maintain bias except during the brief measurement period.

A detailed test plan was written for each test, which included part description, irradiation bias conditions, radiation levels, electrical parameters to be measured, and measurement conditions. The data were processed by hand and by computer, and the calculation of normal standard deviations was made after deletion of clearly erroneous data. Such individual data can be retrieved if required by specifying the log number given with each plot to the Radiation Effects Group (Section 514) at JPL.

B. TESTING WITH A MATRIX BOARD

A matrix board switching system was built to be used as a master control panel. It was located outside of the irradiation area for all in situ tests. The board interfaces the devices under test (DUT) to the power supplies and measurement equipment via a special 15-meter (50-foot), double-shielded cable (see Figure 1). A built-in potentiometer for each DUT can be used to control bias voltages and currents. The matrix board was designed with very high insulation resistance so that very low current measurements (10-50 pA) can be made.

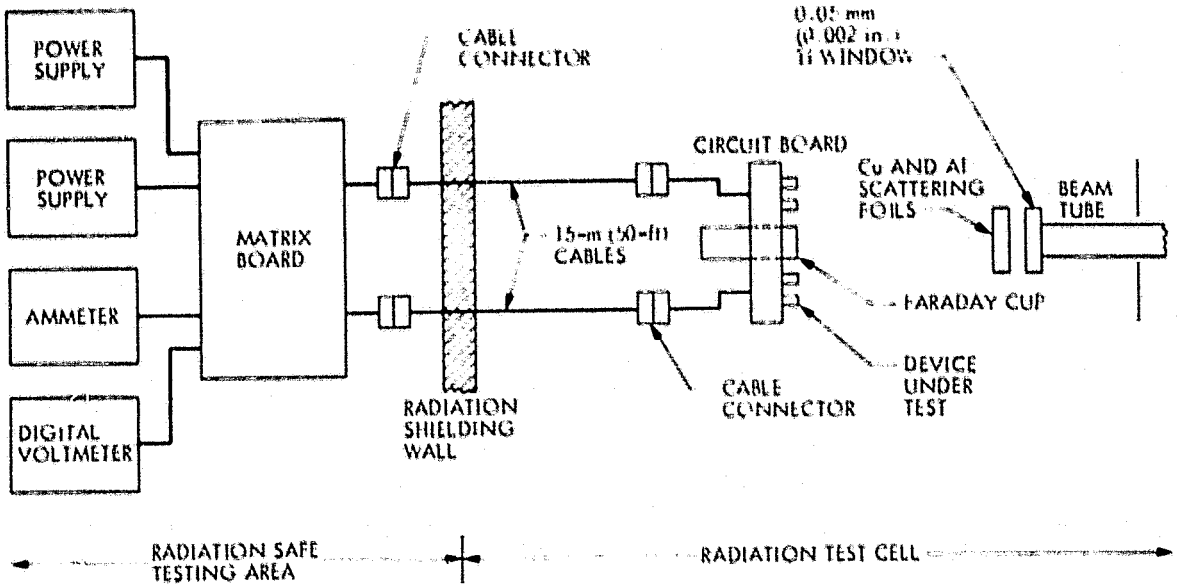


Figure 1. Diagram of the Test Setup for in situ Testing With the Dynamitron

C. TESTING WITHOUT A MATRIX BOARD

For the remote (non in situ) tests, the DUTs are removed from the site for approximately 20 minutes between each radiation level. A mobile bias (battery) is applied to the devices at all times except during parameter measurements. Remote measurements include tests at a Lorlin impact 100 pulsed tester for some of the transistors and readings from a Tektronix 178/577 curve tracer for testing some operational amplifiers. Occasionally, custom test circuits are used in the test to simulate the device application.

D. TESTING AT BREL

A number of ICs were tested for JPL by BREL personnel. Complex LSI devices--such as A/D converters, memories, and microprocessors--were irradiated with the BREL Dynamitron or Cobalt-60 sources and tested on a Tektronix 3260 computerized IC tester. Most of these tests were non in situ. The test programs were written by BREL to JPL's specifications.

SECTION VI

DATA PRESENTATION

A. GRAPH NOMENCLATURE

The data are presented in this section and in Volume II. A sample graph, explaining the nomenclature, is shown in Figure 2. Each of the electrical parameter data plots is represented by a single line per graph except for bipolar transistor data, which use multiple lines to represent different collector currents. A table at the bottom of each graph lists the test conditions when applicable and the normal standard deviations of each data point at each dose level.[2]

The dose units are in Grays (Gy) where 1 Gray equals 100 rads. For purposes of comparison, 10^{13} 3-MeV electrons/cm^2 = 250,000 rads(Si) = 2500 Gy(Si).

Date codes usually indicate when the device was packaged. For example, 7920 indicates the device was packaged in the twentieth week of 1979. If no date code is available, the space may be used for other identifying numbers such as wafer number or lot number.

[2]The log-normal distribution actually provides a better fit to most radiation data than the normal distribution. Hence, caution should be exercised in estimating worst-case conditions based on the limited statistical data presented here.

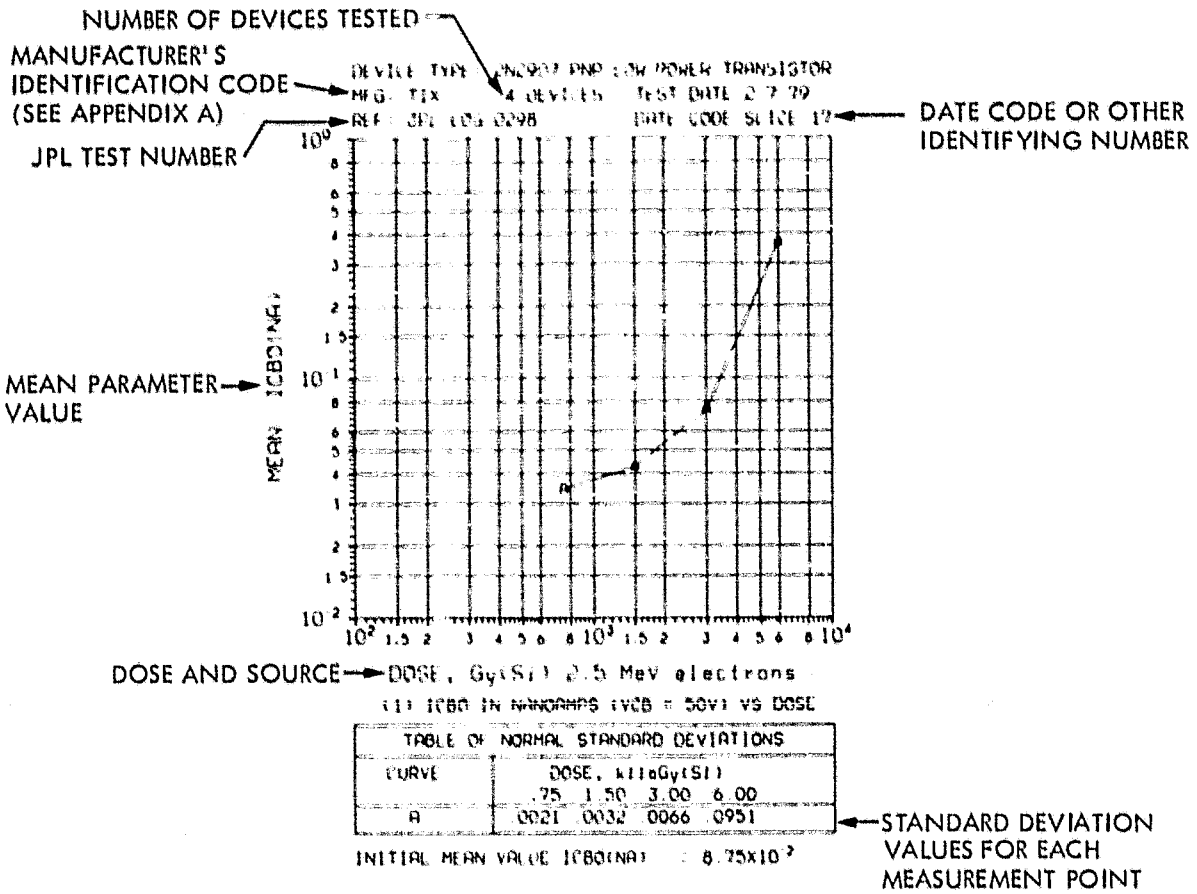
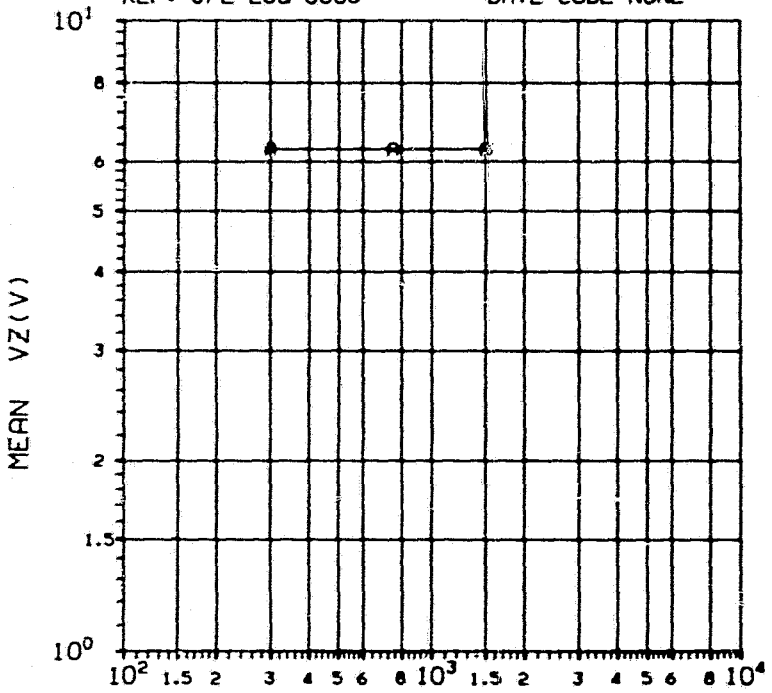


Figure 2. Description of Graph Format

B. DIODES

Radiation tests of diodes have been very limited for space programs because of the inherent radiation hardness at the total worst-case dose levels [3 kGy(Si)]. Testing may be required for special high-precision applications or for higher total-dose environments where very large (orders of magnitude) increases in the leakage current can be expected.

DEVICE TYPE: 1N829 DIODE
MFG: MOT 5 DEVICES TEST DATE 10-27-80
REF: JPL LOG 0688 DATE CODE NONE

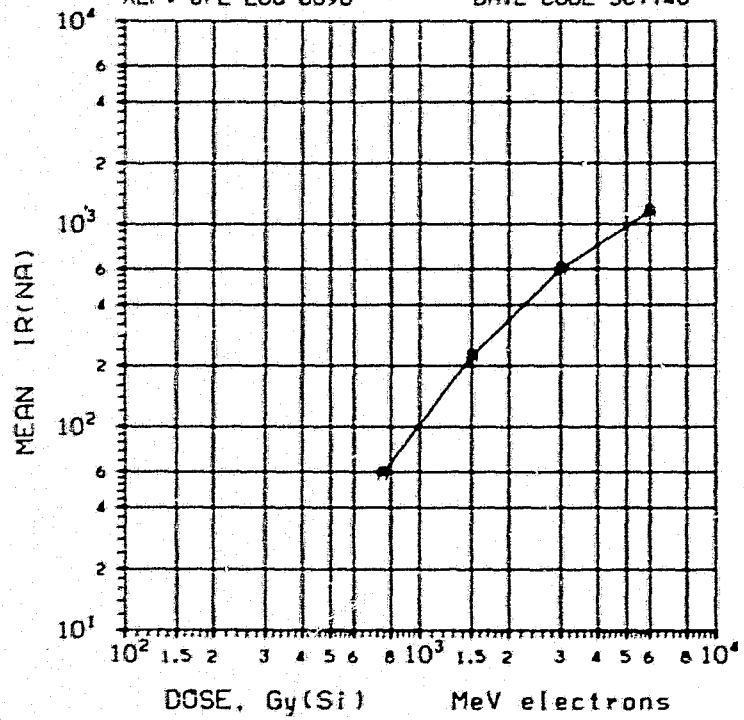


(1) VZ IN VOLTS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.30	.75	1.50
A	.0449	.0478	.0475

INITIAL MEAN VALUE VZ(V) = $6.28X10^0$

DEVICE TYPE: 1N3645 DIODE
MFG: SET 5 DEVICES TEST DATE 10-30-80
REF: JPL LOG 0696 DATE CODE SC7740

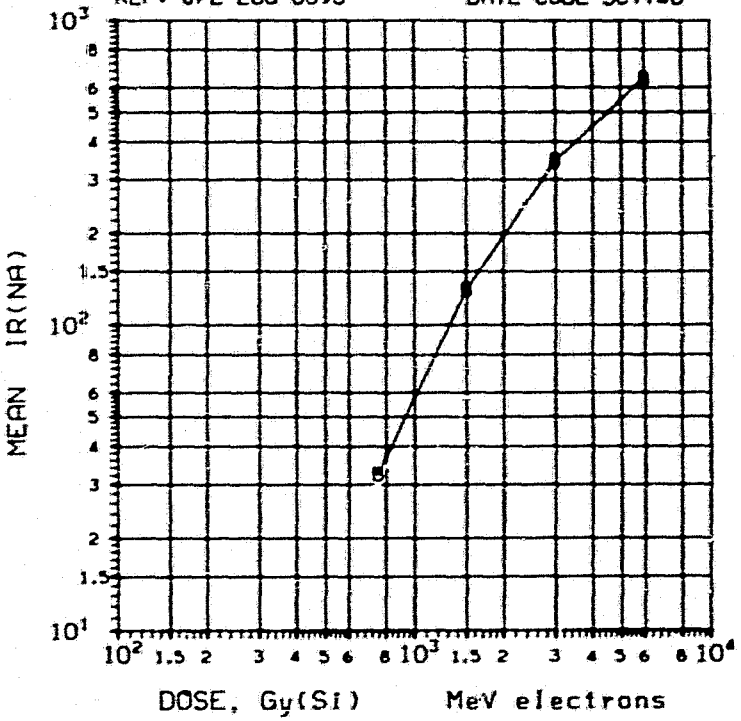


(1) IR IN NA; VR=1000V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	64.39	192.5	471.4	916.1

INITIAL MEAN VALUE IR(NA) = $1.24 \times 10^{+1}$

DEVICE TYPE: 1N3645 DIODE
MFG: SET 5 DEVICES TEST DATE 10-30-80
REF: JPL LOG 0696 DATE CODE SC7740

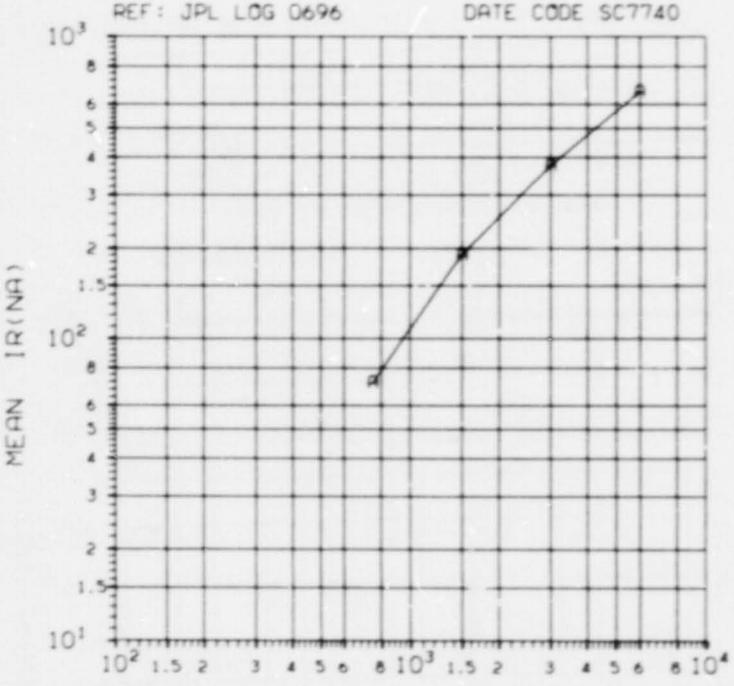


(2) IR IN NA; VR=600V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	23.82	106.1	326.5	685.6

INITIAL MEAN VALUE IR(NA) = $1.02 \times 10^{+1}$

DEVICE TYPE: 1N3645 DIODE
MFG: SET 5 DEVICES TEST DATE 10-30-80
REF: JPL LOG 0696 DATE CODE SC7740

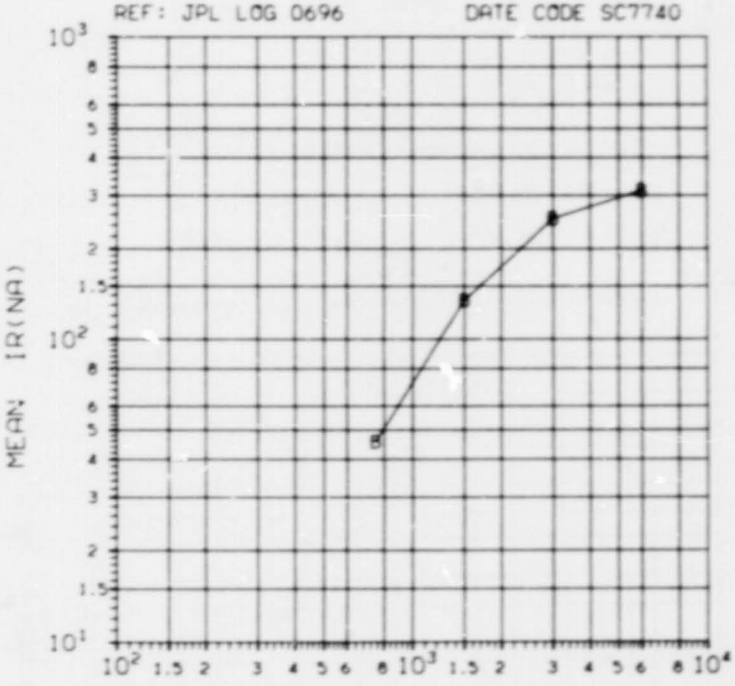


(1) IR IN NA; VR=1000V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	62.11	150.5	264.1	613.7

INITIAL MEAN VALUE IR(NA) = $1.27 \times 10^{+1}$

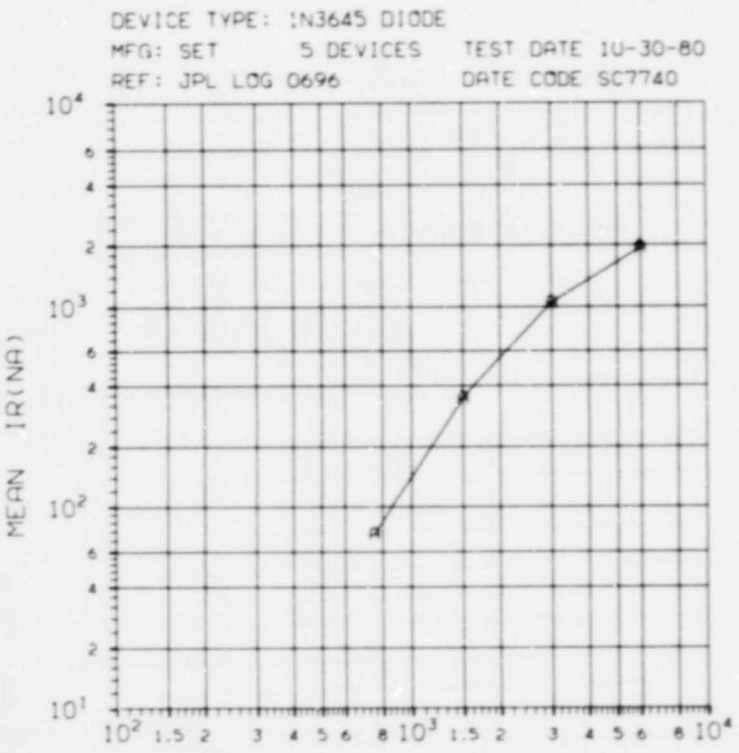
DEVICE TYPE: 1N3645 DIODE
MFG: SET 5 DEVICES TEST DATE 10-30-80
REF: JPL LOG 0696 DATE CODE SC7740



(2) IR IN NA; VR=600V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	36.68	136.1	262.4	258.3

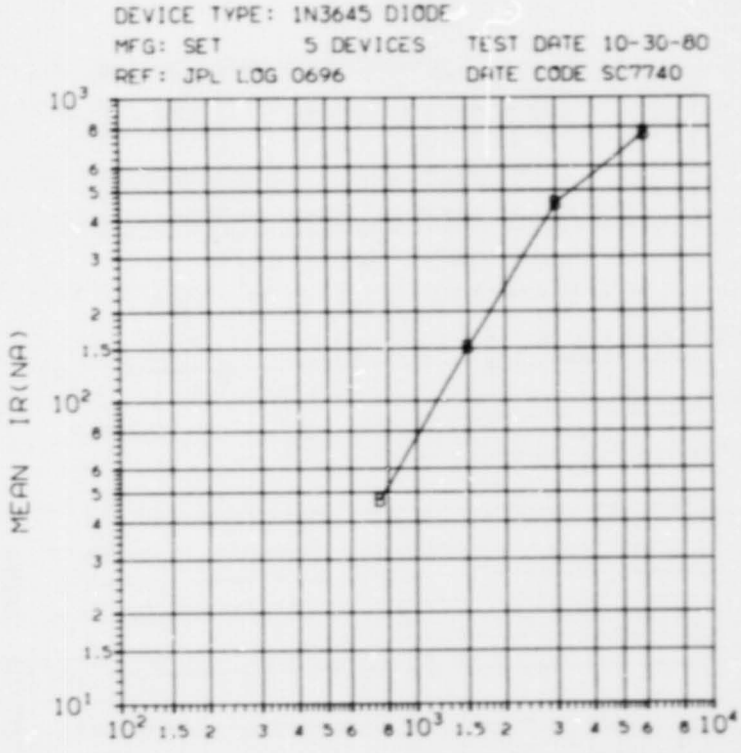
INITIAL MEAN VALUE IR(NA) = $1.10 \times 10^{+1}$



(1) IR IN NA; VR=1000V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	70.41	297.4	839.6	1543.

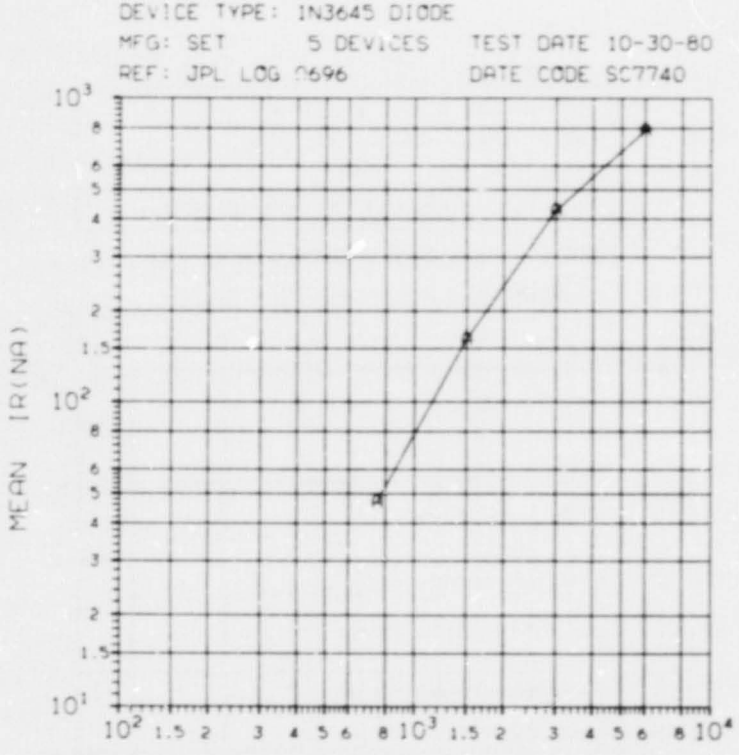
INITIAL MEAN VALUE IR(NA) = $1.19 \times 10^{+1}$



(2) IR IN NA; VR=600V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	50.81	172.6	550.4	942.5

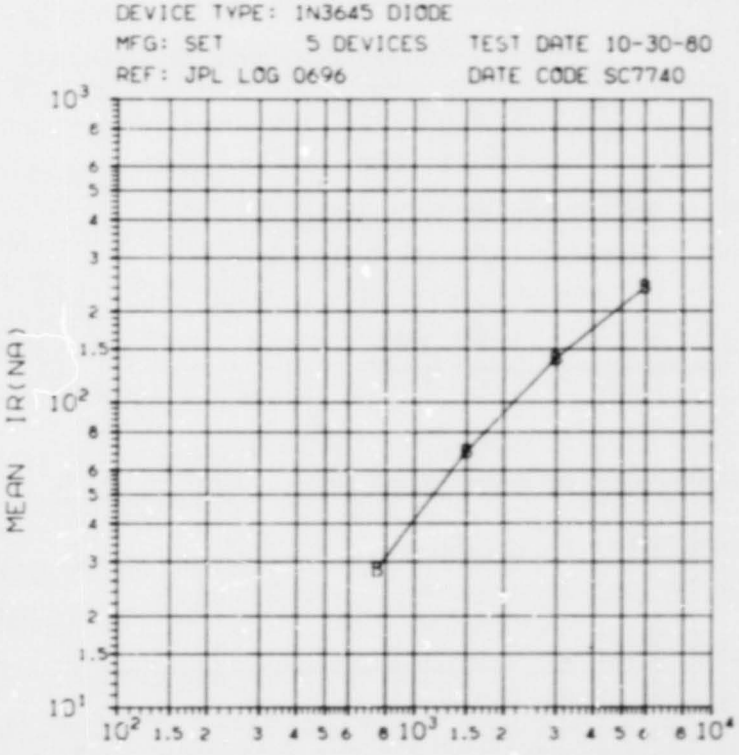
INITIAL MEAN VALUE IR(NA) = 9.70×10^{0}



(1) IR IN NA; VR=1000V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	36.23	144.7	381.3	569.5

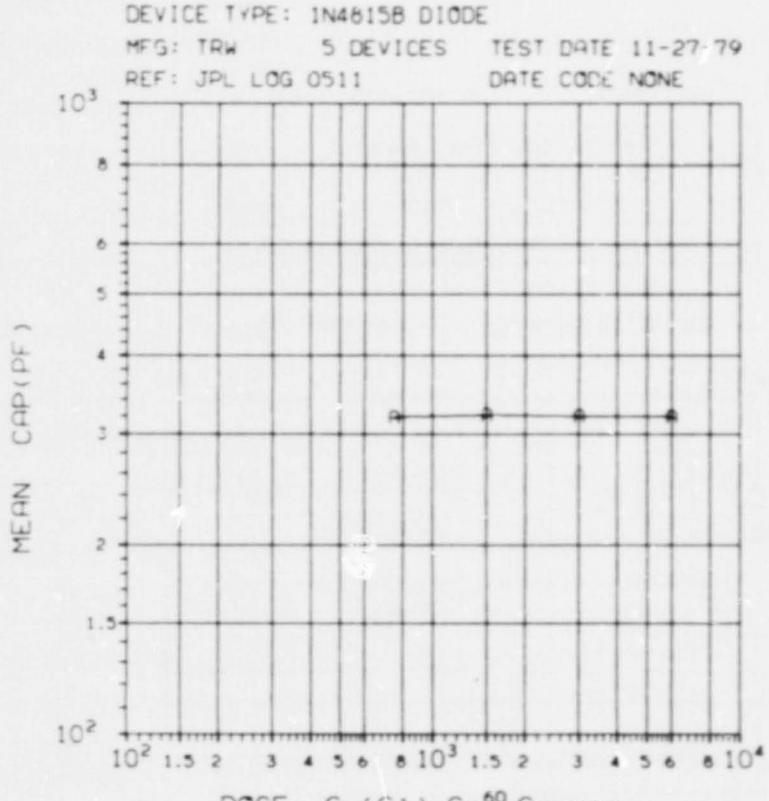
INITIAL MEAN VALUE IR(NA) = $1.46 \times 10^{+1}$



(2) IR IN NA; VR=600V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	19.39	51.40	102.3	175.0

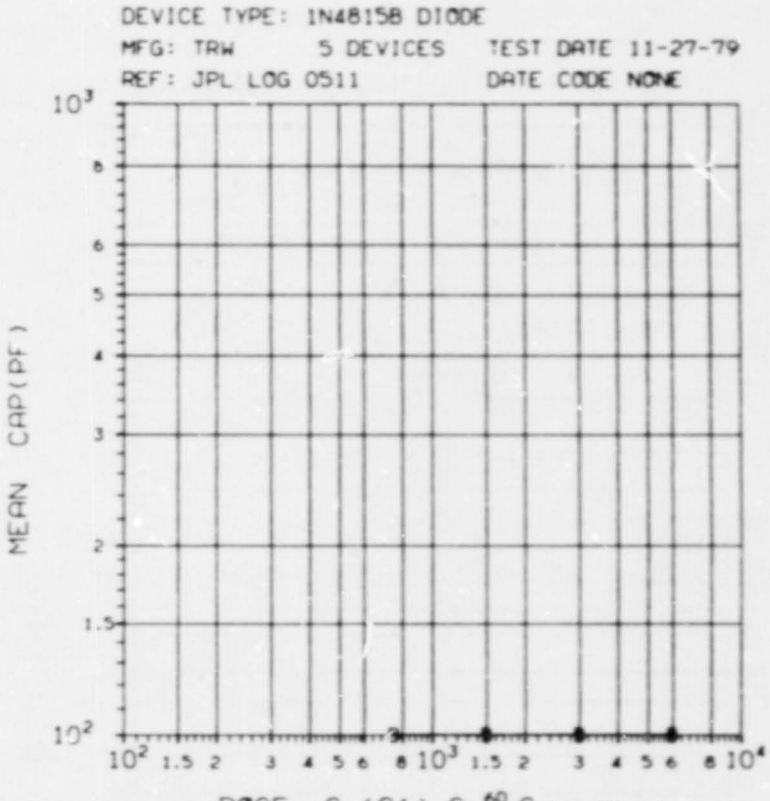
INITIAL MEAN VALUE IR(NA) = $1.27 \times 10^{+1}$



(1) CAPACITANCE (VR=0VDC) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	6.637	8.173	6.914	9.086

INITIAL MEAN VALUE CAP(PF) = $3.1X10^{+2}$

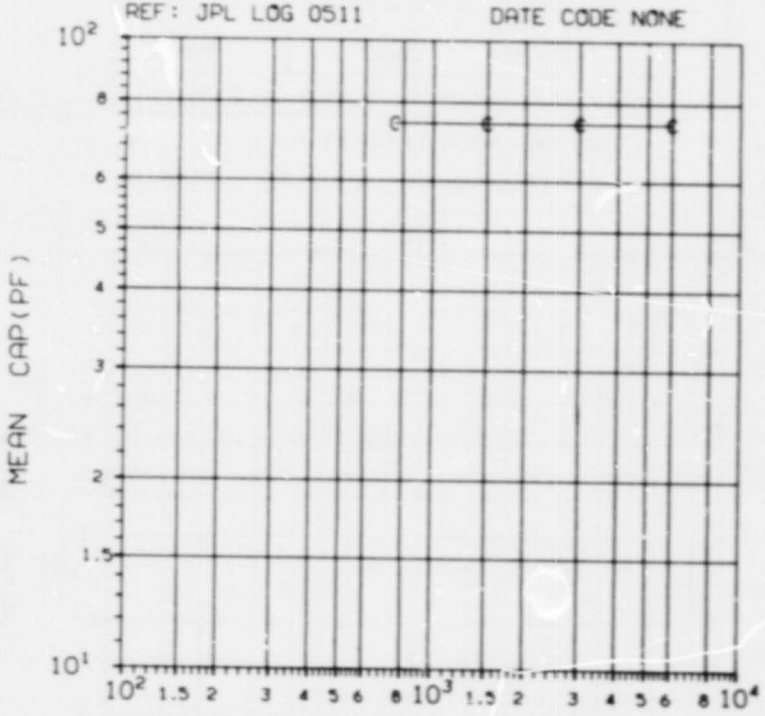


(2) CAPACITANCE (VR=4VDC) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	2.584	2.532	2.556	2.542

INITIAL MEAN VALUE CAP(PF) = $1.0X10^{+2}$

DEVICE TYPE: 1N4815B DIODE
MFG: TRW 5 DEVICES TEST DATE 11-27-79
REF: JPL LOG 0511 DATE CODE NONE

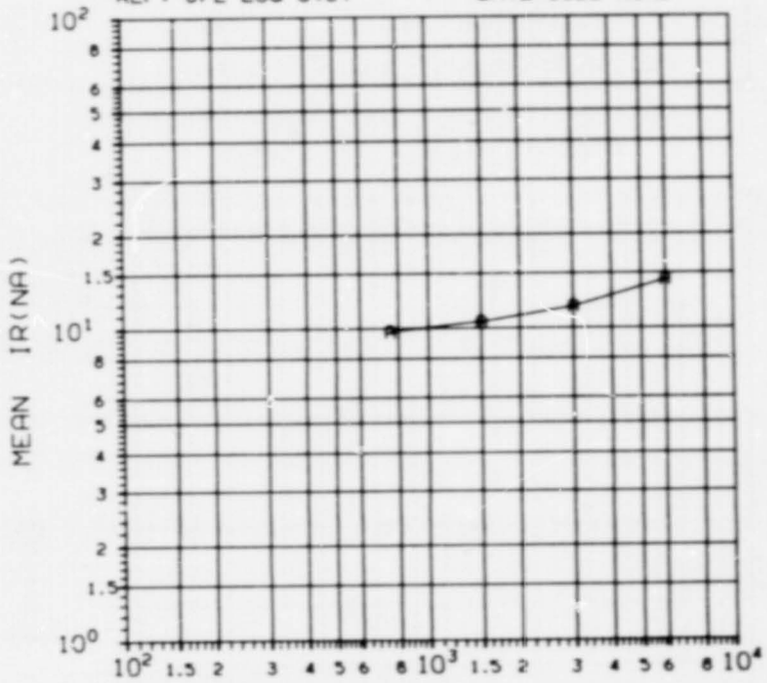


(3) CAPACITANCE (VR=3VDC) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
C	1.887	1.875	1.896	1.882

INITIAL MEAN VALUE CAP(PF) = $7.42 \times 10^{+1}$

DEVICE TYPE: FD 643-2 DIODE
MFG: FAS 5 DEVICES TEST DATE 2-25-81
REF: JPL LOG 0707 DATE CODE NONE



(1) IR IN NA (VR=30V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	1.107	.9363	.7512	.7241

INITIAL MEAN VALUE IR(NA) = $1.18X10^{+1}$

C. BIPOLAR TRANSISTORS

The degradation in transistor gain (h_{FE}) is plotted as $\Delta(1/h_{FE}) = 1/h_{FE\phi} - 1/h_{FEo}$, where $h_{FE\phi}$ is the value at the specified radiation level, and h_{FEo} is the initial value. This subject was discussed in Section III, paragraph B.

A method of determining the final h_{FE}, when initial h_{FE} and the post-irradiation $\Delta(1/h_{FE})$ are known, is shown in the following example for a 2N2222 device type at V_{CE} of 20 V at 3 kGy(Si):

1. Scale the value of $\Delta(1/h_{FE})$ from the applicable graph for a 2N2222 transistor at the stated conditions. In this example, $\Delta(1/h_{FE})$ is determined to be 0.008.

2. Determine the minimum specified pre-irradiation h_{FE} for this device type. In this example, the initial specified minimum h_{FE} is 100. Then proceed as follows:

$$h_{FE}(\text{final}) = \frac{1}{\Delta(1/h_{FE}) + \dfrac{1}{h_{FEo}(\text{initial})}}$$

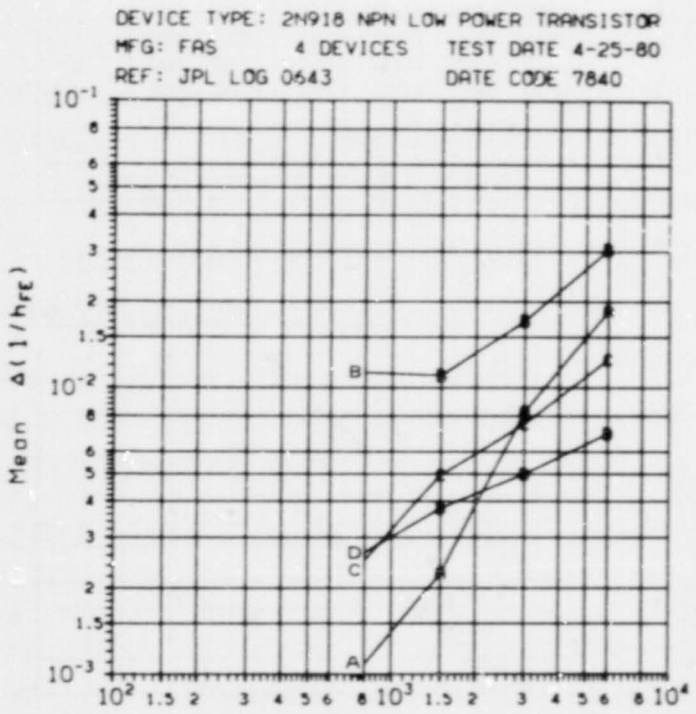
$$h_{FE}(\text{final}) = \frac{1}{0.008 + \dfrac{1}{100}} = 55.6$$

Table 6-1 may also be used to determine the final h_{FE}. Locate the post-irradiation $\Delta(1/h_{FE})$ value in the left-hand column. Locate the initial h_{FE} on the top row. Where the column and row intersect is the final h_{FE}.

The data on leakage and saturation currents are plotted directly as a function of dose.

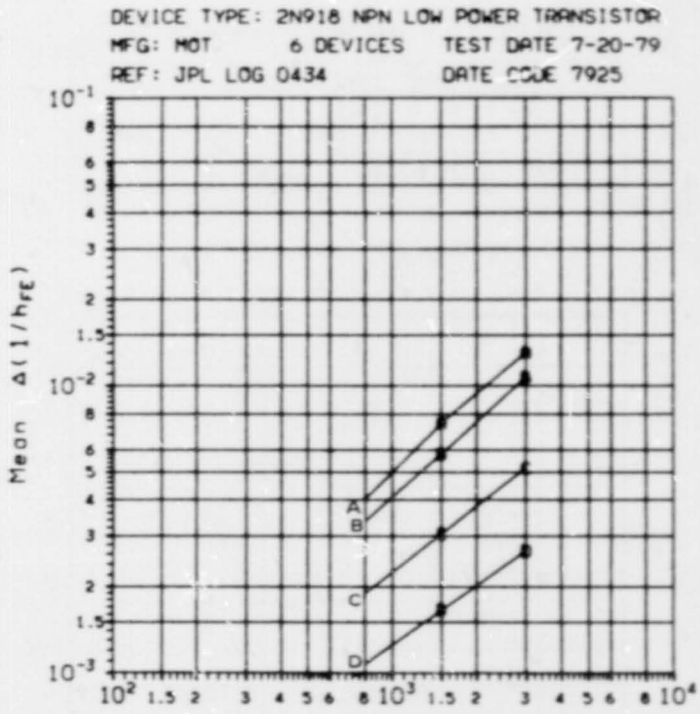
Table 1. Determination of Final h_{FE}, Given Initial h_{FEo} and Post-Irradiation $\Delta(1/h_{FE})$

$\Delta(\frac{1}{h_{FE}})$	h_{FEo}																													
	10	12	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	110	120	130	140	150	170	200	250	300	350	400
.0005	9.95	11.9	14.9	19.8	24.7	29.6	34.4	39.2	44.1	48.8	53.3	58.1	62.9	67.6	72.5	76.9	81.2	86.2	90.9	95.2	104	114	122	132	139	156	[illegible]	222	263	294	333
.0007	9.92	11.9	14.9	19.7	24.6	29.4	34.1	38.9	43.7	48.3	52.9	57.5	61.7	66.7	71.4	75.8	80.0	84.8	89.3	93.5	102	111	119	128	135	152	175	[illegible]	250	278	313
.001	9.90	11.9	14.8	19.6	24.4	29.[illegible]	33.8	38.5	43.1	47.6	52.1	56.6	61.0	65.4	69.9	74.1	78.1	82.6	87.0	90.9	99.[illegible]	107	115	124	130	145	167	200	233	256	286
.0015	9.85	11.8	14.7	19.4	24.1	[illegible]	[illegible]	37.7	42.2	46.5	51.8	55.0	59.2	63.4	67.6	71.4	75.2	79.4	83.3	87.0	94.3	102	109	116	122	135	154	182	208	227	250
.002	9.80	11.7	14.6	19.2	23.8	28.3	32.7	37.0	41.3	45.5	49.5	53.6	57.5	61.4	65.4	69.0	72.5	76.3	80.0	83.3	90.1	96.8	103	110	115	127	143	167	189	204	222
.0025	9.76	11.7	14.5	19.0	23.5	27.9	32.2	36.4	40.5	44.4	48.3	52.2	55.9	59.6	63.3	66.7	69.9	73.5	76.9	80.0	86.2	92.3	98.0	104	109	119	133	[illegible]	172	185	200
.003	9.71	11.6	14.3	18.9	23.3	27.5	31.7	35.7	39.7	43.5	47.2	50.8	54.4	57.9	61.4	64.5	67.6	70.9	74.1	76.9	82.6	88.2	93.5	99.0	103	112	125	143	159	170	182
.0035	9.66	11.5	14.3	18.7	23.0	27.2	31.2	35.1	38.9	42.6	46.1	49.5	52.9	56.2	59.5	62.5	65.4	68.5	71.4	74.1	79.4	84.8	89.3	94.3	98.0	106	118	133	147	156	167
.004	9.62	11.5	14.1	18.5	22.7	26.8	30.7	34.5	38.2	41.7	45.1	48.4	51.6	54.7	57.8	60.6	63.3	66.2	69.0	71.4	76.3	81.1	85.5	90.1	93.8	101	111	125	137	145	154
.005	9.52	11.3	13.9	18.2	22.2	26.1	29.9	33.3	36.8	40.0	43.1	46.2	49.0	51.9	54.6	57.1	59.5	62.1	64.5	66.7	70.9	75.0	78.7	82.6	85.7	91.7	100	111	121	127	133
.006	9.43	11.2	13.8	17.9	21.7	25.4	28.9	32.3	35.5	38.5	41.3	44.1	46.7	49.3	51.8	54.1	56.2	58.5	60.6	62.5	66.2	69.8	73.0	76.3	79.0	84.0	90.9	100	108	112	118
.007	9.35	11.1	13.6	17.5	21.3	24.8	28.1	31.3	34.3	37.0	39.7	42.3	44.6	47.0	49.3	51.3	53.2	55.2	57.1	58.8	62.1	65.2	68.0	70.9	73.2	77.5	83.3	90.9	97.1	101	105
.008	9.26	11.0	13.4	17.2	20.8	24.2	27.4	30.3	33.1	35.7	38.2	40.5	42.7	44.9	47.0	48.8	50.5	52.4	54.1	55.6	58.5	61.2	63.7	66.2	68.2	71.9	76.9	83.3	86.5	91.7	95.2
.009	9.17	10.8	13.2	16.9	20.4	23.6	26.6	29.4	32.1	34.5	36.8	39.0	41.0	42.9	44.8	46.5	48.1	49.8	51.3	52.6	55.3	57.7	60.0	62.1	63.8	67.1	71.4	76.9	81.3	84.0	87.0
.010	9.09	10.7	13.0	16.7	20.0	23.1	26.0	28.6	31.1	33.3	35.5	37.5	39.4	41.2	42.9	44.4	45.9	47.4	48.8	50.0	52.4	54.5	56.5	58.5	60.0	62.9	66.7	71.4	75.2	77.5	80.0
.011	9.01	10.6	12.9	16.4	19.6	22.6	25.3	27.7	30.1	32.3	34.3	36.1	37.4	39.5	41.1	42.6	43.4	45.3	46.5	47.6	49.7	51.3	53.5	55.3	56.5	59.2	62.5	66.7	69.9	71.9	74.1
.012	8.93	10.5	12.7	16.1	19.2	22.1	24.7	27.0	29.2	31.3	33.1	34.9	36.5	38.1	39.5	40.8	42.0	43.3	44.4	45.5	47.4	49.2	50.8	52.4	53.6	55.9	58.8	62.5	65.4	67.1	69.0
.013	8.85	10.4	12.6	15.9	18.9	21.6	24.1	26.3	28.4	30.3	32.1	33.7	35.2	36.6	38.0	39.2	40.3	42.5	42.6	43.5	45.3	47.0	48.3	49.8	50.8	52.9	55.6	58.8	61.4	62.0	64.5
.014	8.77	10.3	12.4	15.6	18.5	21.1	23.5	25.6	27.6	29.4	31.1	32.6	34.0	35.1	36.6	37.7	38.8	39.8	40.8	41.7	43.3	44.8	46.1	47.4	48.3	50.3	52.6	55.6	57.8	59.2	60.6
.015	8.70	10.1	12.2	15.4	18.2	20.7	23.0	25.0	26.9	28.6	30.1	31.6	32.9	34.1	35.3	36.4	37.3	38.3	39.2	40.0	41.5	42.9	44.1	45.3	46.2	47.9	50.0	52.6	54.6	55.9	57.1
.017	8.62	10.0	12.0	14.9	17.5	19.9	21.9	23.8	25.5	27.0	28.4	29.7	30.9	32.0	33.0	33.9	34.7	35.6	36.4	37.0	38.3	39.5	40.5	41.5	42.2	43.7	45.5	47.6	49.3	50.3	51.3
.020	8.33	9.67	11.5	14.3	16.7	18.8	20.6	22.2	23.7	25.0	26.2	27.3	28.3	29.2	30.0	30.8	31.5	32.2	32.8	33.3	34.4	35.3	36.1	36.9	37.5	38.6	40.0	41.7	42.9	43.7	44.4
.025	8.00	9.23	10.9	13.3	15.4	17.2	18.7	20.0	21.2	22.2	23.2	24.0	24.7	25.5	29.6	26.7	27.2	27.7	28.2	28.6	29.3	30.0	30.6	31.2	31.6	32.4	33.3	34.5	35.3	35.8	36.4
.030	7.69	8.82	10.3	12.5	14.3	15.8	17.1	18.2	19.2	20.0	20.8	21.4	22.0	22.6	23.1	23.5	23.9	24.3	24.7	25.0	25.6	26.1	26.5	27.0	27.3	27.9	28.6	29.4	29.9	30.4	30.8
.035	7.41	8.48	9.83	11.8	13.3	14.6	15.8	16.7	17.5	18.2	18.7	19.3	19.8	20.3	22.8	21.0	21.4	21.7	22.0	22.2	22.7	23.0	23.4	23.8	24.0	24.5	25.0	25.6	26.1	26.4	26.7
.040	7.14	8.11	9.38	11.1	12.5	13.6	14.6	15.4	16.1	16.7	17.2	17.6	18.0	18.4	18.8	19.0	19.3	19.6	19.8	20.0	20.4	20.7	21.0	21.2	21.4	21.8	22.2	22.7	23.1	23.3	23.5
.050	6.67	7.50	8.57	10.0	11.1	12.0	12.7	13.3	13.9	14.3	14.7	15.0	15.3	15.6	15.8	16.0	16.2	16.4	16.5	16.7	16.9	17.2	17.3	17.8	17.6	17.9	18.2	18.5	18.6	18.9	19.[illegible]
.060	6.25	6.98	7.89	9.09	10.0	10.7	11.3	11.8	12.2	12.5	12.8	13.0	13.3	13.5	13.6	13.8	13.9	14.1	14.2	14.3	14.5	14.6	14.8	14.9	15.0	15.2	15.4	15.6	15.8	15.9	16.0
.070	5.88	6.52	7.32	8.33	9.09	9.71	10.1	10.5	10.8	11.1	11.3	11.5	11.7	11.8	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.8	12.9	13.0	13.0	13.2	13.3	13.5	13.6	13.7	13.8
.080	5.56	6.12	6.82	7.69	8.33	8.85	9.21	9.52	9.8	10.0	10.2	10.3	10.5	10.6	10.7	10.8	10.9	11.0	11.1	11.1	11.2	11.3	11.4	11.5	11.5	11.6	11.8	11.9	12.0	12.1	12.1
.090	5.26	5.77	6.38	7.14	7.69	8.13	8.42	8.70	8.9[illegible]	9.09	9.25	9.38	9.49	9.59	9.68	9.76	9.68	9.89	9.95	10.0	10.1	10.2	10.2	10.3	10.3	10.4	10.5	10.6	10.7	10.8	10.8
.100	5.00	5.45	6.00	6.67	7.14	7.52	7.81	8.00	8.2	8.33	8.46	8.57	8.67	8.75	8.83	8.89	8.95	9.00	9.05	9.09	9.17	9.23	9.29	9.34	9.28	9.44	9.52	9.62	9.68	9.72	9.76



Δ(1/h_{FE}) VS DOSE

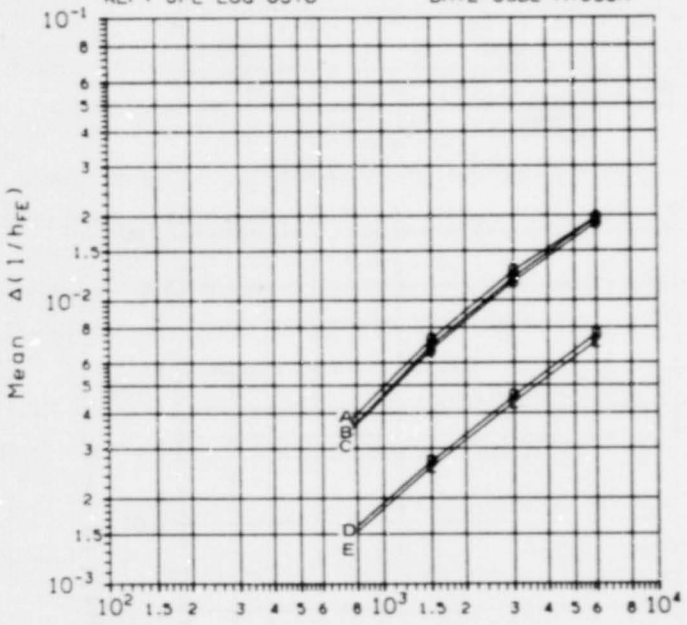
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (uA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	10.00	5.00	.0050	.0101	.0116	.0130
B	10.00	5.00	.0365	.0265	.0279	.0266
C	100.0	5.00	.0039	.0045	.0051	.0051
D	1000.	5.00	.0011	.0009	.0012	.0014



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (uA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
A	10.00	5.00	.0007	.0018	.0029
B	10.00	5.00	.0005	.0012	.0022
C	100.0	5.00	.0003	.0006	.0009
D	1000.	5.00	.0002	.0004	.0005

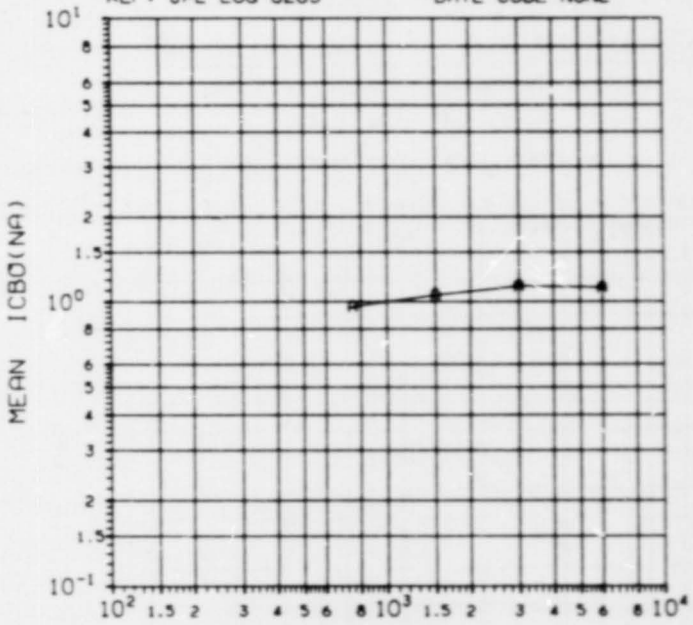
DEVICE TYPE: 2N2060 NPN LOW POWER TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 5-11-79
REF: JPL LOG 0370 DATE CODE A7550A



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.000	20.0	.0014	.0027	.0056	.0091
B	1.000	20.0	.0014	.0023	.0049	.0082
C	1.000	.500	.0014	.0024	.0050	.0085
D	10.00	.500	.0005	.0008	.0016	.0026
E	10.00	20.0	.0004	.0008	.0015	.0024

DEVICE TYPE: 2N2060 NPN LOW POWER TRANSISTOR
MFG: TIX 5 DEVICES TEST DATE 5-22-79
REF: JPL LOG 0283 DATE CODE NONE

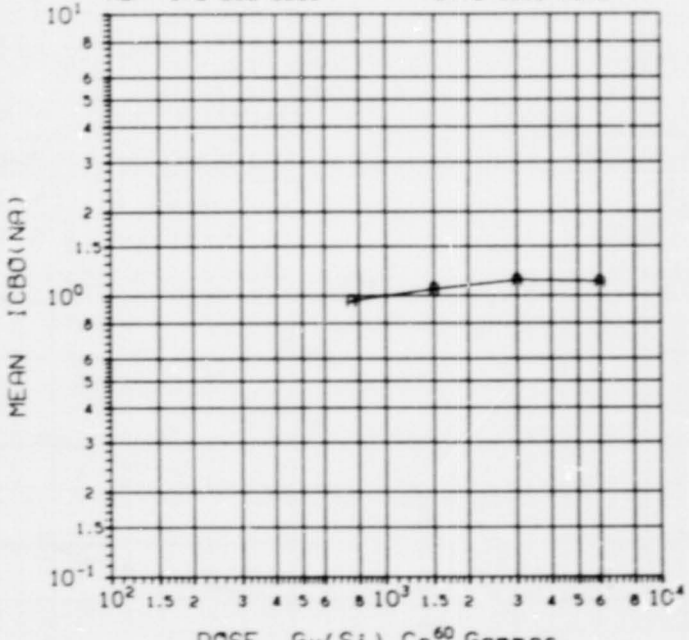


(1) ICBO (IN NA); VCE=30V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.1430	.2365	.2440	.1256

INITIAL MEAN VALUE ICBO(NA) = 1.30×10^{0}

DEVICE TYPE: 2N2060 NPN LOW POWER TRANSISTOR
MFG: TIX 5 DEVICES TEST DATE 5-22-79
REF: JPL LOG 0283 DATE CODE NONE

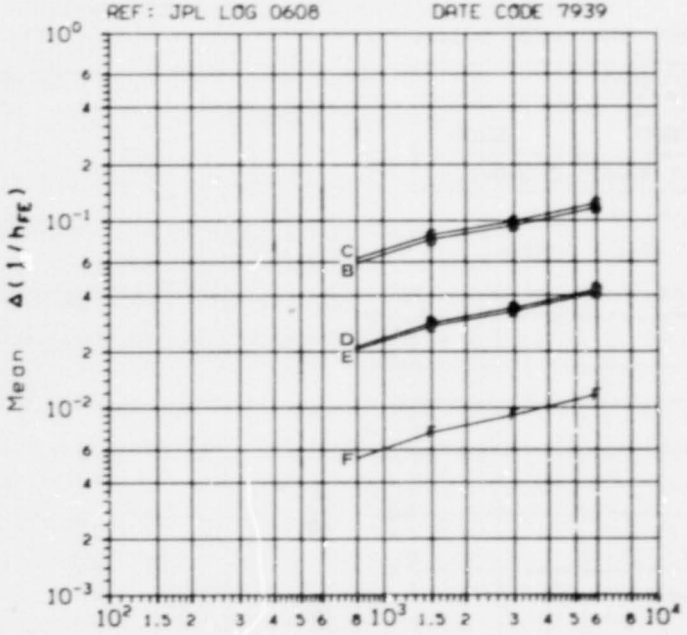


(1) ICBO (IN NA); VCE=30V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.1430	.2365	.2440	.1256

INITIAL MEAN VALUE ICBO(NA) = 1.30×10^{-9}

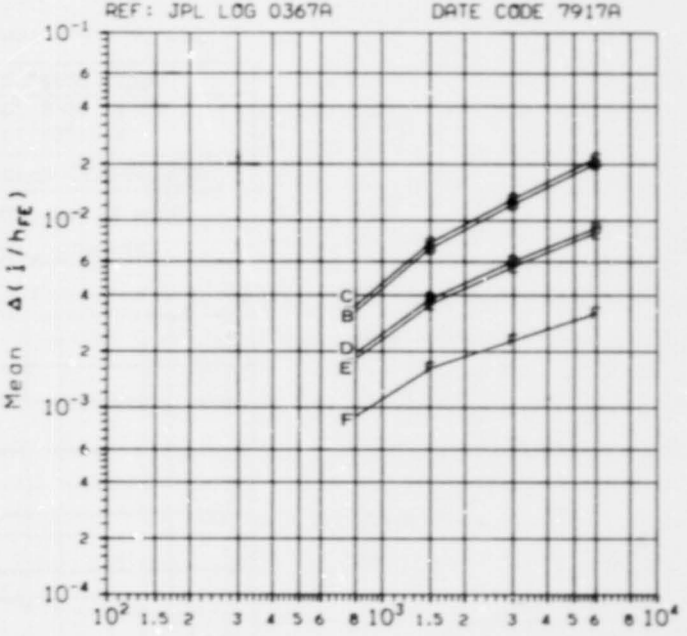
DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: FAS 3 DEVICES TEST DATE 3-4-80
REF: JPL LOG 0608 DATE CODE 7939



Δ(1/hFE) VS DOSE

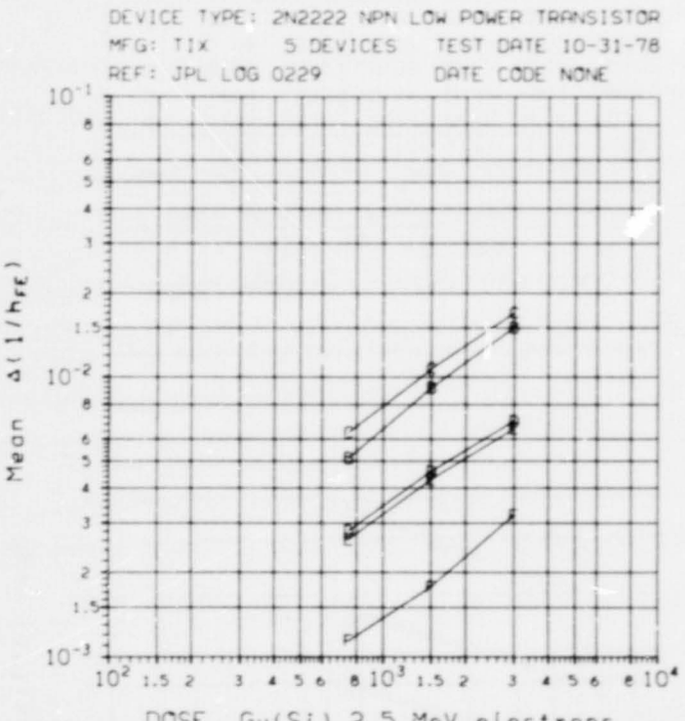
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_r (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0173	.0198	.0210	.0288
C	.100	.500	.0182	.0207	.0219	.0299
D	1.00	.500	.0064	.0075	.0083	.0113
E	1.00	20.0	.0060	.0072	.0079	.0107
F	20.0	20.0	.0013	.0019	.0024	.0032

DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 5-8-79
REF: JPL LOG 0367A DATE CODE 7917A



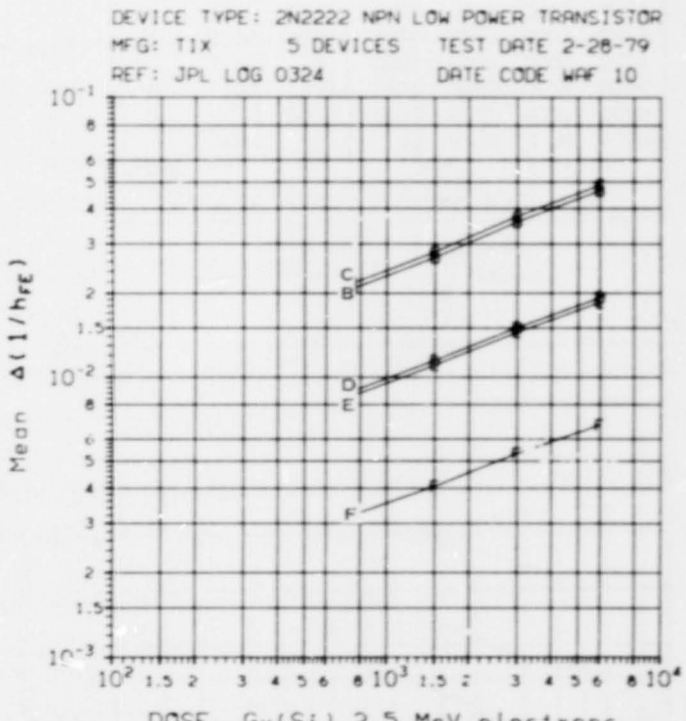
Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_c (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.30	3.00	6.00
B	.100	20.0	.0021	.0027	.0040	.0050
C	.100	.500	.0023	.0029	.0042	.0055
D	1.00	.500	.0012	.0011	.0015	.0018
E	1.00	20.0	.0011	.0011	.0015	.0017
F	20.0	20.0	.0005	.0003	.0004	.0004



$\Delta(1/h_{FE})$ VS DOSE

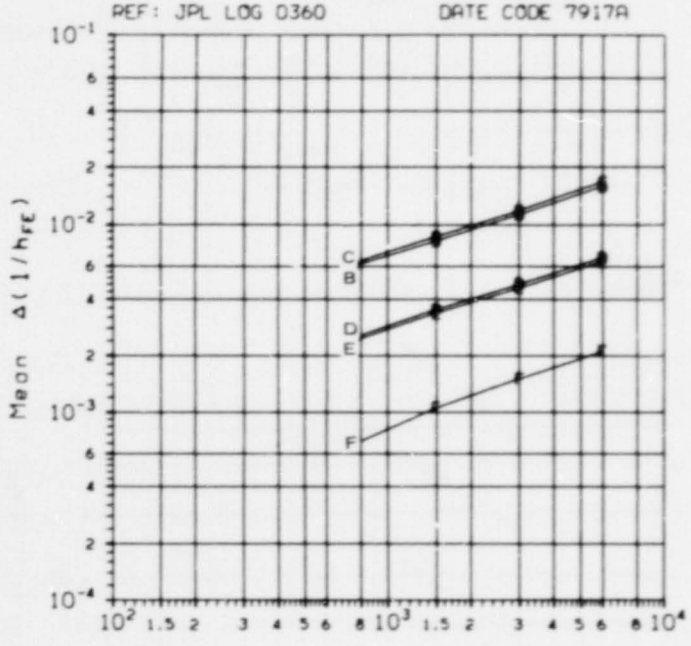
TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
B	.100	20.0	.0055	.0091	.0122
C	.100	.500	.0078	.0116	.0149
D	1.00	.500	.0023	.0035	.0044
E	1.00	20.0	.0022	.0033	.0041
F	20.0	20.0	.0007	.0009	.0015



$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0157	.0188	.0247	.0305
C	.100	.500	.0163	.0196	.0257	.0319
D	1.00	.500	.0058	.0072	.0093	.0114
E	1.00	20.0	.0057	.0070	.0090	.0111
F	20.0	20.0	.0019	.0023	.0030	.0036

DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 5-4-79
REF: JPL LOG 0360 DATE CODE 7917A

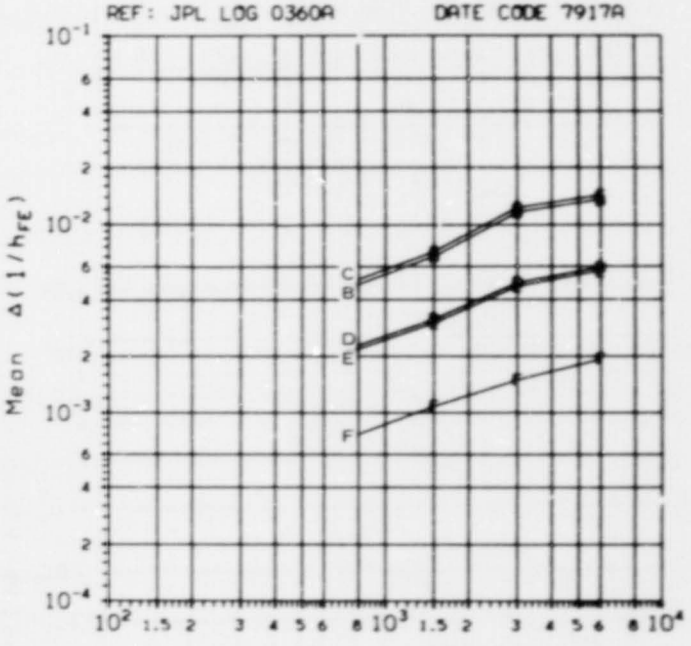


DOSE, Gy(Si) 2.5 MeV electrons

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0013	.0012	.0010	.0012
C	.100	.500	.0012	.0012	.0011	.0013
D	1.00	.500	.0002	.0002	.0002	.0003
E	1.00	20.0	.0002	.0002	.0002	.0004
F	20.0	20.0	.0001	.0001	.0002	.0002

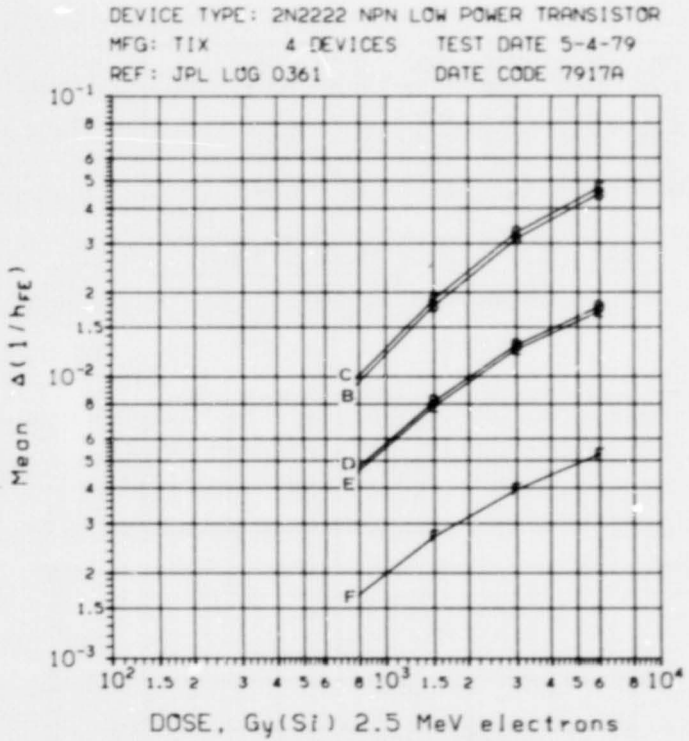
DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: TIX 3 DEVICES TEST DATE 5-8-79
REF: JPL LOG 0360A DATE CODE 7917A



DOSE, Gy(Si) Co^{60} Gammas

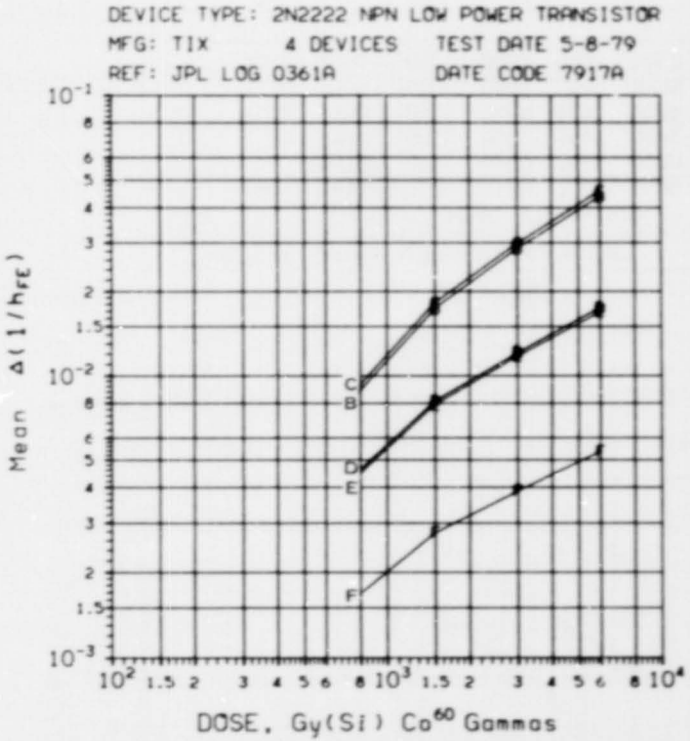
$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0018	.0022	.0033	.0025
C	.100	.500	.0019	.0023	.0034	.0026
D	1.00	.500	.0006	.0007	.0009	.0007
E	1.00	20.0	.0006	.0007	.0009	.0007
F	20.0	20.0	.0001	.0001	.0001	.0001



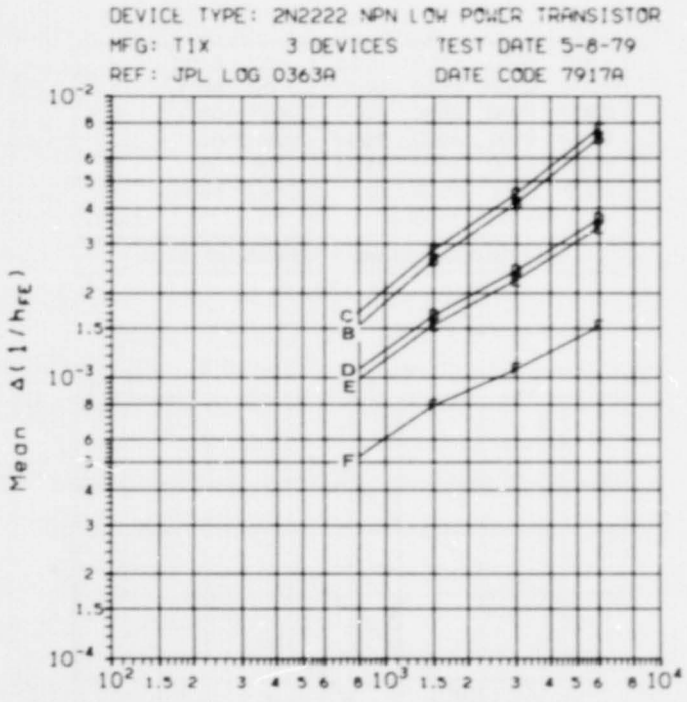
$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0004	.0009	.0015	.0014
C	.100	.500	.0004	.0009	.0016	.0015
D	1.00	.500	.0002	.0003	.0004	.0005
E	1.00	20.0	.0002	.0003	.0005	.0004
F	20.0	20.0	.0001	.0001	.0001	.0001



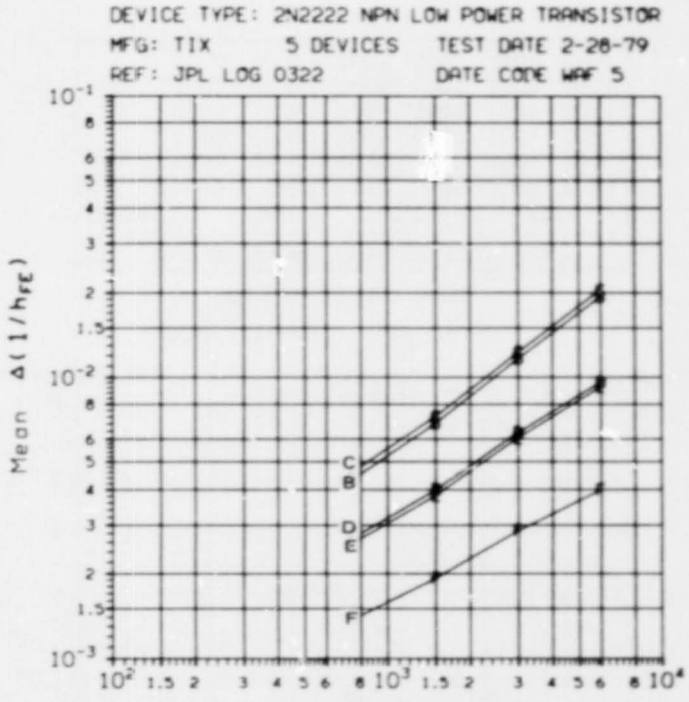
$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0010	.0016	.0024	.0026
C	.100	.500	.0011	.0017	.0025	.0027
D	1.00	.500	.0006	.0007	.0009	.0011
E	1.00	20.0	.0005	.0007	.0009	.0011
F	20.0	20.0	.0003	.0002	.0004	.0004



$\Delta(1/h_{FE})$ VS DOSE

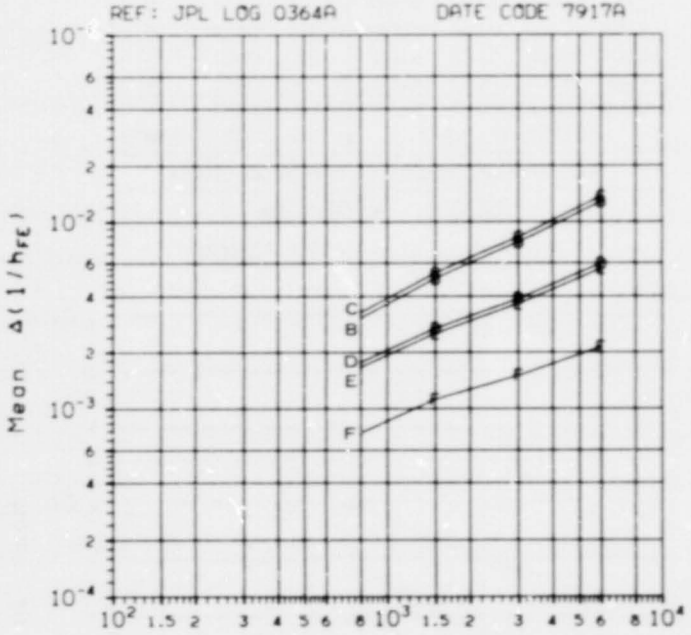
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0001	.0002	.0003	.0005
C	.100	.500	.0002	.0002	.0004	.0005
D	1.00	.500	.0001	.0001	.0001	.0001
E	1.00	20.0	.0001	.0001	.0001	.0001
F	20.0	20.0	.0000	.0000	.0000	.0000



$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0017	.0020	.0026	.0030
C	.100	.500	.0018	.0021	.0027	.0031
D	1.00	.500	.0005	.0005	.0007	.0007
E	1.00	20.0	.0005	.0005	.0007	.0008
F	20.0	20.0	.0001	.0001	.0001	.0002

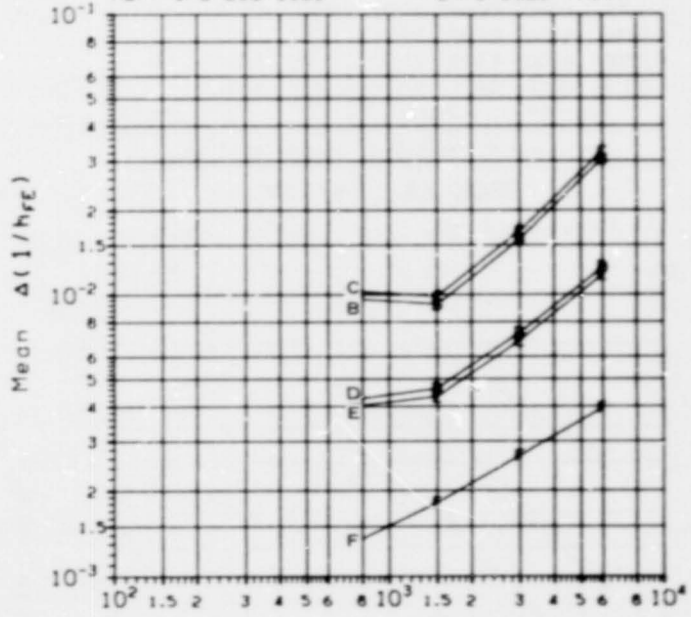
DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: TIX 3 DEVICES TEST DATE 5-8-79
REF: JPL LOG 0364A DATE CODE 7917A



$\Delta(1/h_{FE})$ VS DOSE

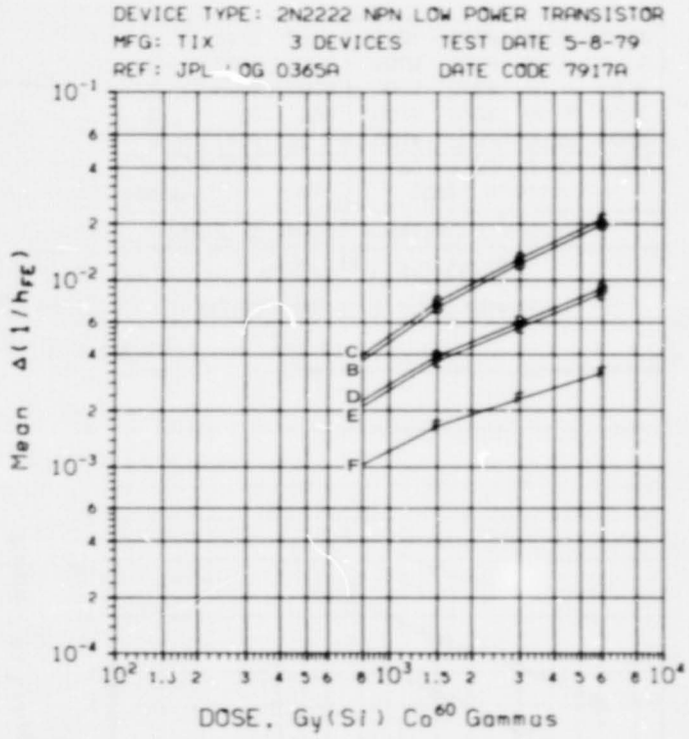
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0014	.0022	.0032	.0047
C	.100	.500	.0016	.0024	.0035	.0051
D	1.00	.500	.0005	.0008	.0011	.0016
E	1.00	20.0	.0005	.0008	.0011	.0015
F	20.0	20.0	.0001	.0002	.0002	.0002

DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 5-9-79
REF: JPL LOG 0365 DATE CODE 7917A



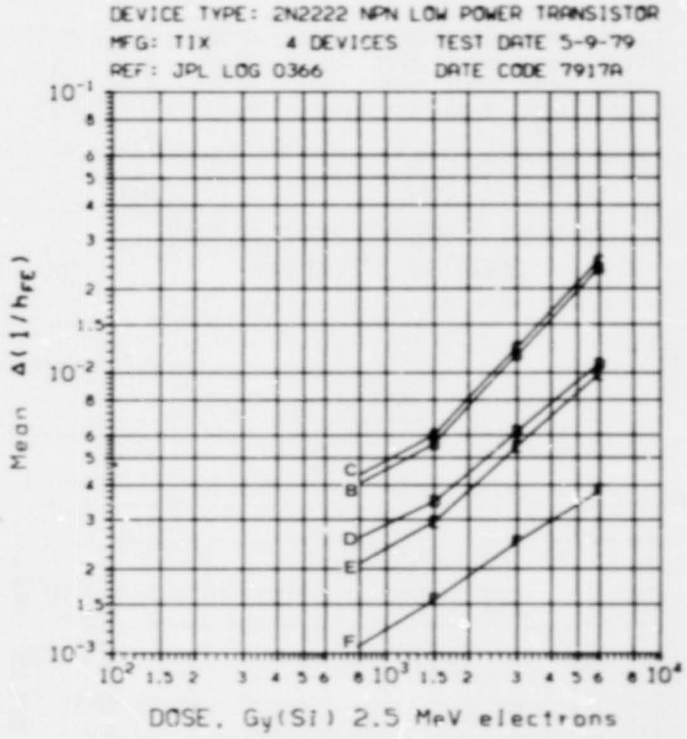
$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0111	.0073	.0091	.0121
C	.100	.500	.0118	.0078	.0097	.0129
D	1.00	.500	.0036	.0026	.0030	.0035
E	1.00	20.0	.0034	.0025	.0028	.0033
F	20.0	20.0	.0005	.0005	.0005	.0005



$\Delta(1/h_{FE})$ VS DOSE

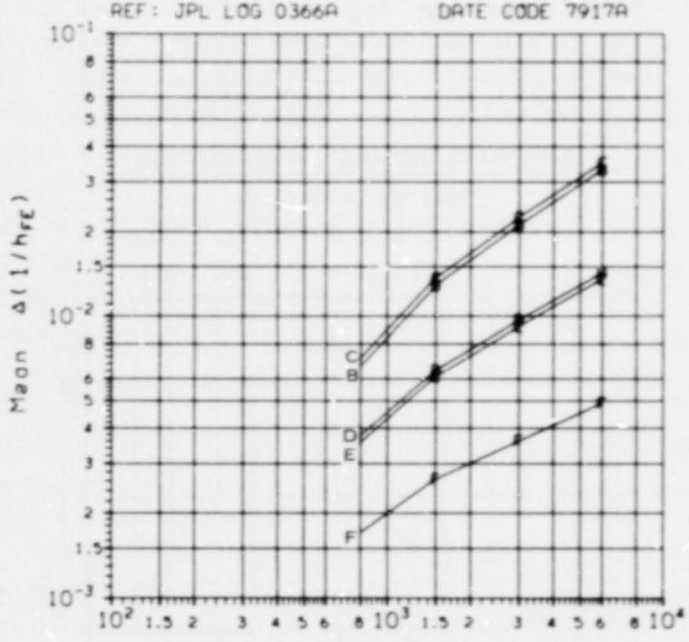
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0014	.0030	.0041	.0051
C	.100	.500	.0015	.0032	.0044	.0054
D	1.00	.500	.0006	.0011	.0015	.0016
E	1.00	20.0	.0006	.0011	.0014	.0015
F	20.0	20.0	.0002	.0003	.0003	.0003



$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0012	.0013	.0019	.0023
C	.100	.500	.0012	.0013	.0019	.0023
D	1.00	.500	.0005	.0006	.0007	.0008
E	1.00	20.0	.0005	.0005	.0006	.0007
F	20.0	20.0	.0001	.0001	.0001	.0002

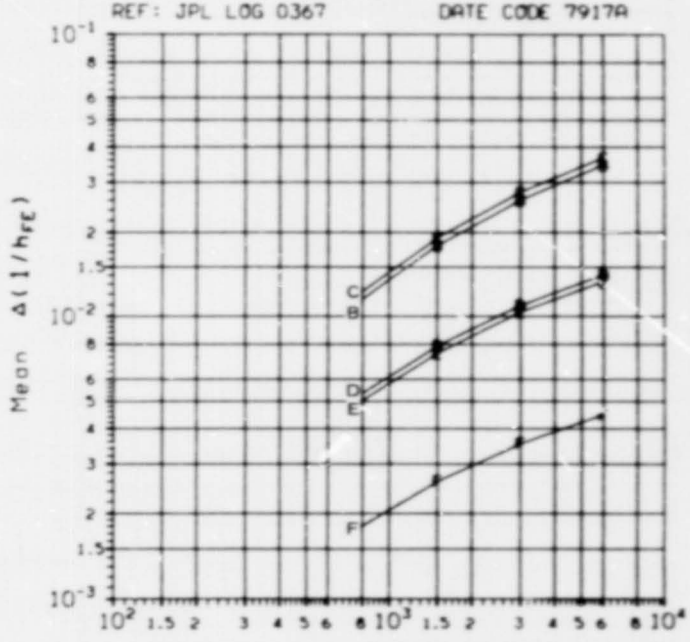
DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: TIX 3 DEVICES TEST DATE 5-8-79
REF: JPL LOG 0366A DATE CODE 7917A



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0058	.0116	.0174	.0238
C	.100	.500	.0061	.0122	.0185	.0250
D	1.00	.500	.0028	.0048	.0067	.0087
E	1.00	20.0	.0026	.0046	.0064	.0084
F	20.0	20.0	.0011	.0016	.0020	.0025

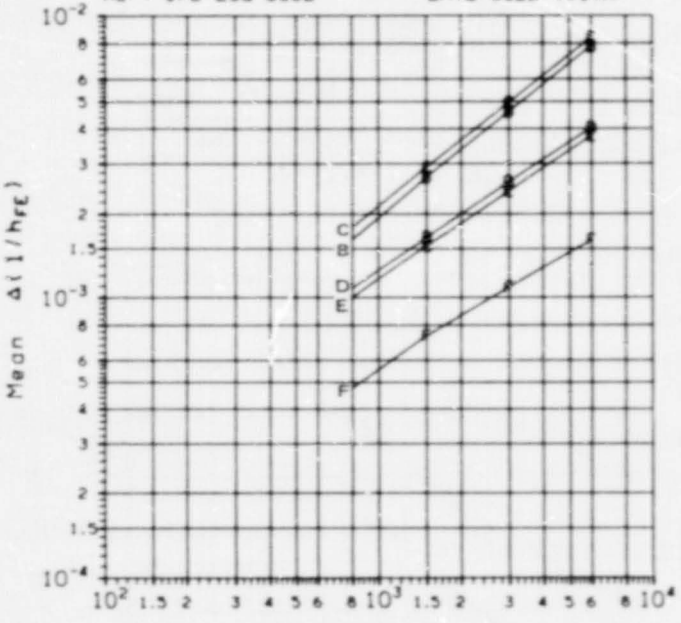
DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 5-4-79
REF: JPL LOG 0367 DATE CODE 7917A



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0086	.0122	.0173	.0164
C	.100	.500	.0091	.0130	.0183	.0174
D	1.00	.500	.0034	.0046	.0055	.0057
E	1.00	20.0	.0033	.0044	.0053	.0055
F	20.0	20.0	.0009	.0012	.0014	.0015

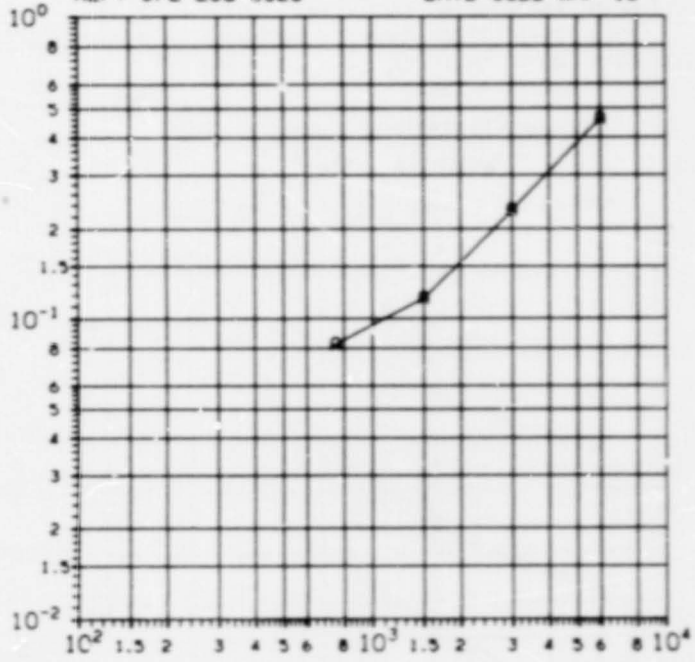
DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 5-4-79
REF: JPL LOG 0362 DATE CODE 7917A



$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.100	20.0	.0002	.0003	.0004	.0007
C	.100	.500	.0002	.0003	.0005	.0007
D	1.00	.500	.0001	.0001	.0002	.0003
E	1.00	20.0	.0001	.0001	.0002	.0003
F	20.0	20.0	.0000	.0001	.0001	.0001

DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: TIX 5 DEVICES TEST DATE 2-28-79
REF: JPL LOG 0325 DATE CODE WAF 10



(1) ICBO IN NANOAMPS (VCB=15V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0270	.0244	.0369	.0438

INITIAL MEAN VALUE ICBO(NA) = 8.58×10^{-2}

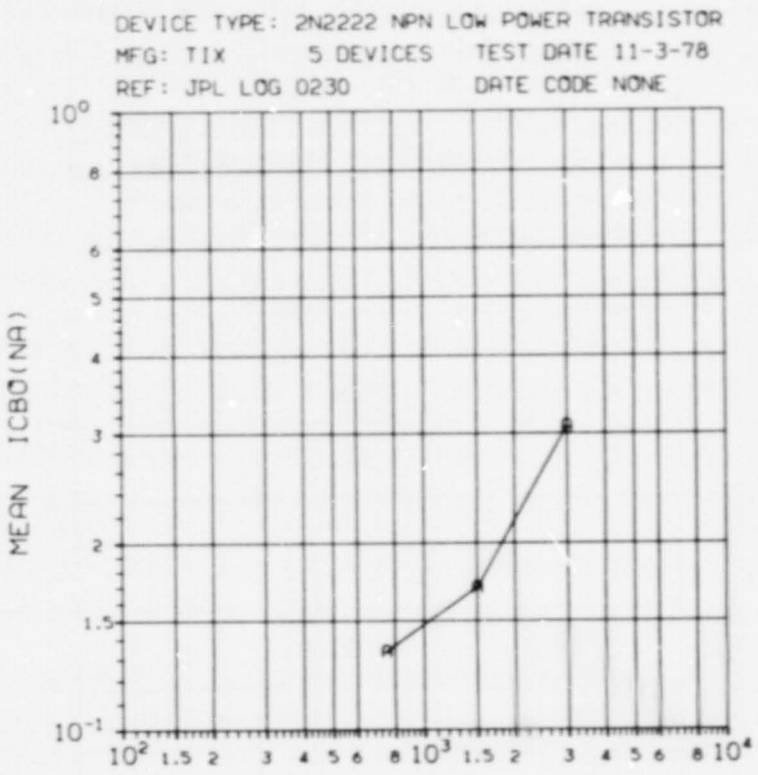


TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.75	1.50	3.00
A	.0207	.0274	.0460

INITIAL MEAN VALUE ICBO(NA) = 8.9×10^{-2}

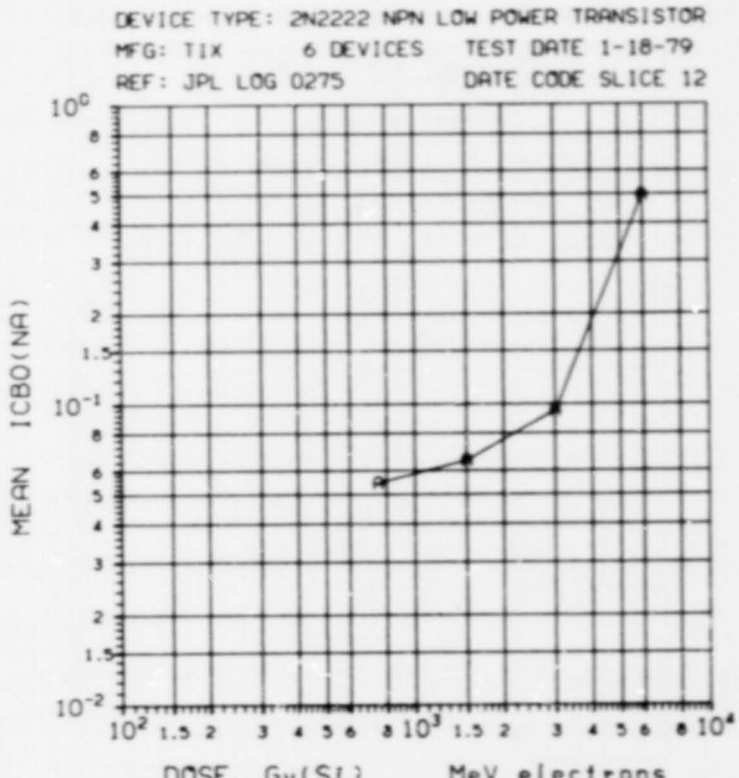
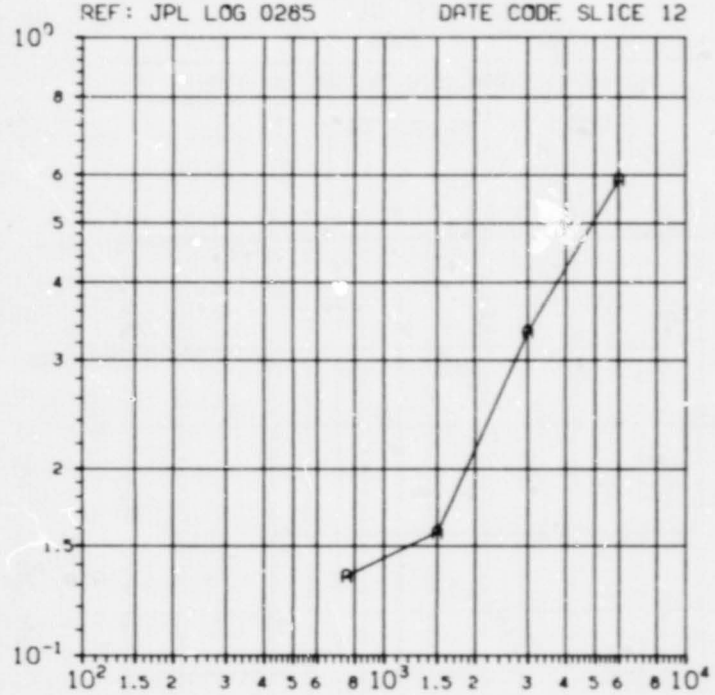


TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0086	.0052	.0150	.0944

INITIAL MEAN VALUE ICBO(NA) = 6.88×10^{-2}

DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: TI 6 DEVICES TEST DATE 1-19-79
REF: JPL LOG 0285 DATE CODE SLICE 12

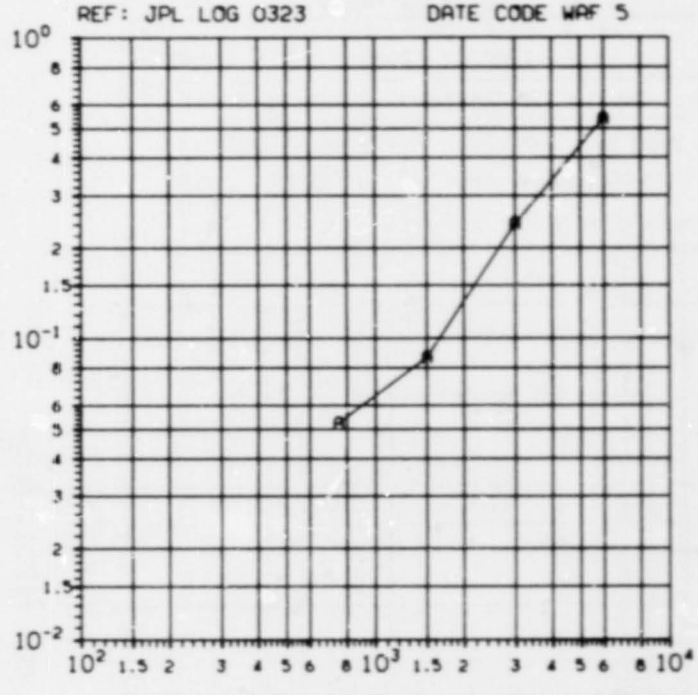


(1) ICBO IN NANOAMPS (VCE = 15V): VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0240	.0212	.0403	.0354

INITIAL MEAN VALUE ICBO(NA) = 1.12×10^{-1}

DEVICE TYPE: 2N2222 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 2-28-79
REF: JPL LOG 0323 DATE CODE WAF 5

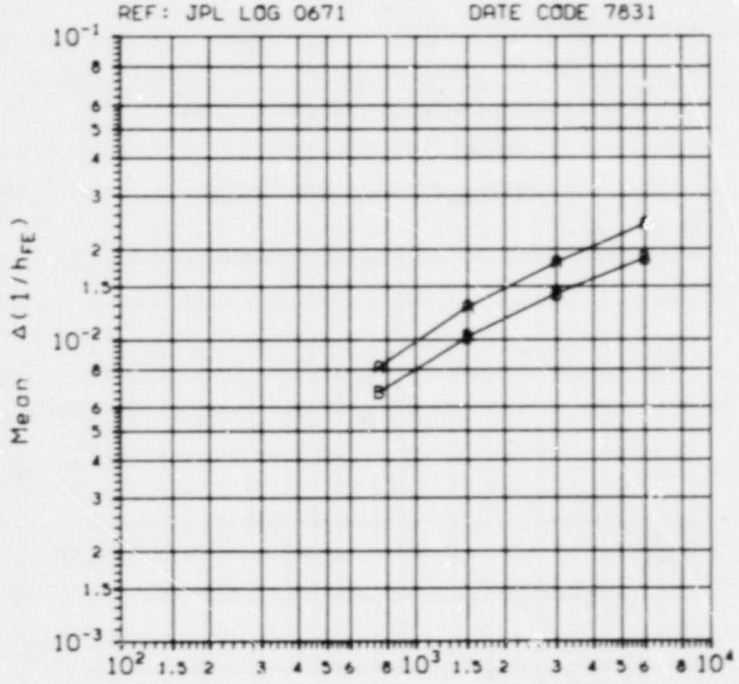


(1) ICBO IN NANOAMPS (VCB=15V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0019	.0029	.0062	.0141

INITIAL MEAN VALUE ICBO(NA) = 4.32×10^{-2}

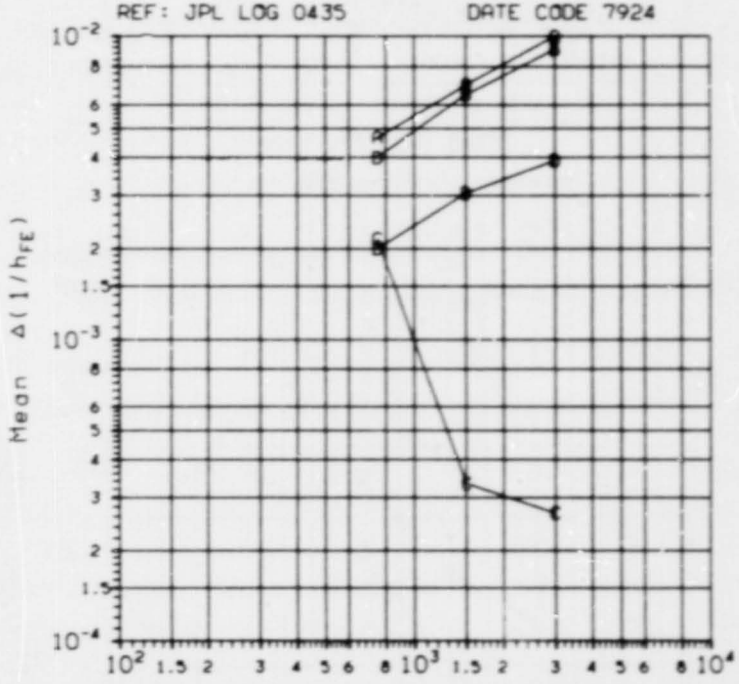
DEVICE TYPE: 2N2369A NPN LOW POWER TRANSISTO
MFG: FAS 3 DEVICES TEST DATE 8-7-80
REF: JPL LOG 0671 DATE CODE 7831



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (uA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	150.0	5.00	.0103	.0157	.0214	.0264
B	300.0	5.00	.0078	.0119	.0157	.0188

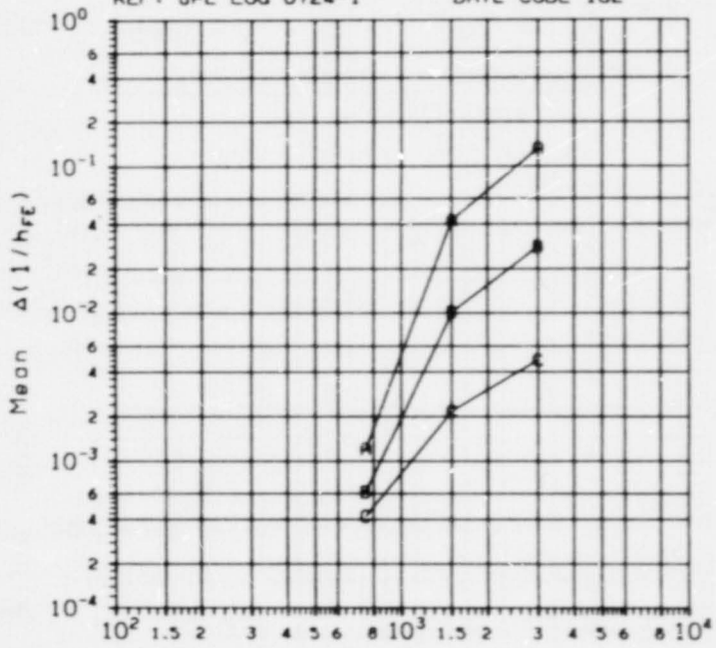
DEVICE TYPE: 2N2369A NPN LOW POWER TRANSISTO
MFG: MOT 6 DEVICES TEST DATE 7-19-79
REF: JPL LOG 0435 DATE CODE 7924



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
A	2.000	.400	.0004	.0006	.0008
B	2.000	.400	.0003	.0005	.0008
C	10.00	.400	.0004	.0013	.0005
D	55.00	.400	.0003	.0004	.0005

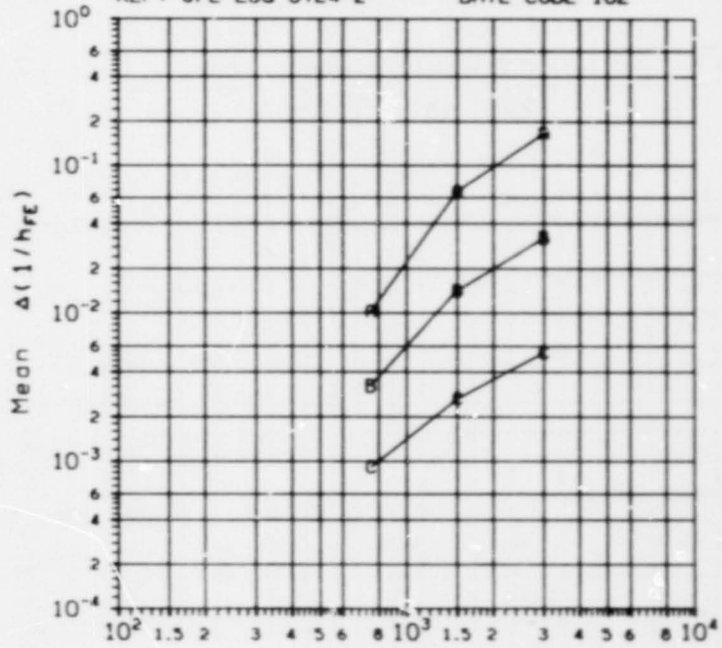
DEVICE TYPE: 2N2432 NPN LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 3-18-81
REF: JPL LOG 0724-1 DATE CODE 102



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
A	.1000	10.0	.0004	.0334	.0693
B	1.000	10.0	.0003	.0070	.0123
C	10.00	10.0	.0002	.0013	.0018

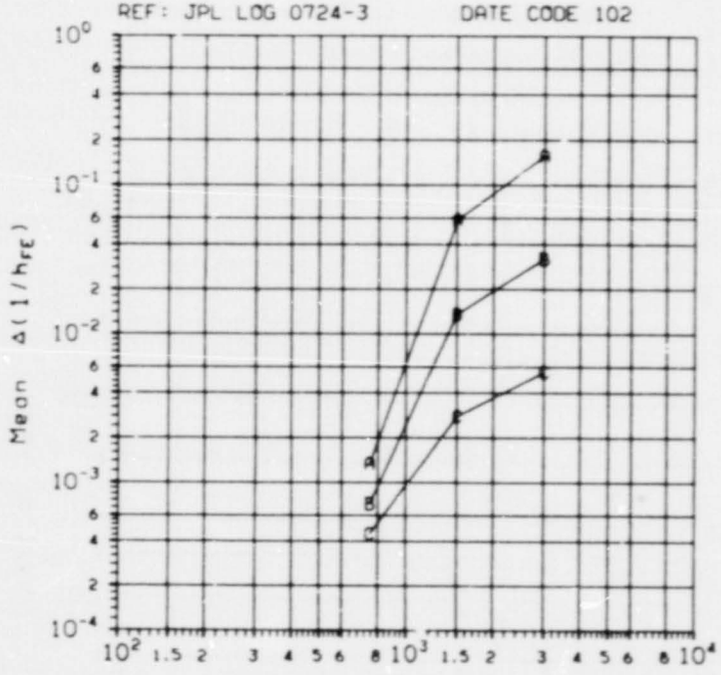
DEVICE TYPE: 2N2432 NPN LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 3-18-81
REF: JPL LOG 0724-2 DATE CODE 102



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
A	.1000	10.0	.0143	.0832	.1453
B	1.000	10.0	.0040	.0149	.0228
C	10.00	10.0	.0010	.0023	.0033

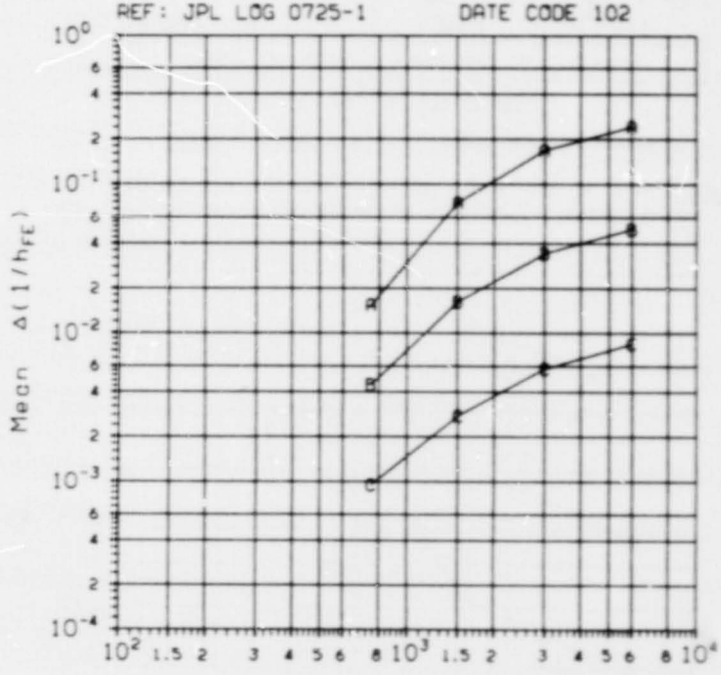
DEVICE TYPE: 2N2432 NPN LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 3-18-81
REF: JPL LOG 0724-3 DATE CODE 102



Δ(1/h_{FE}) VS DOSE

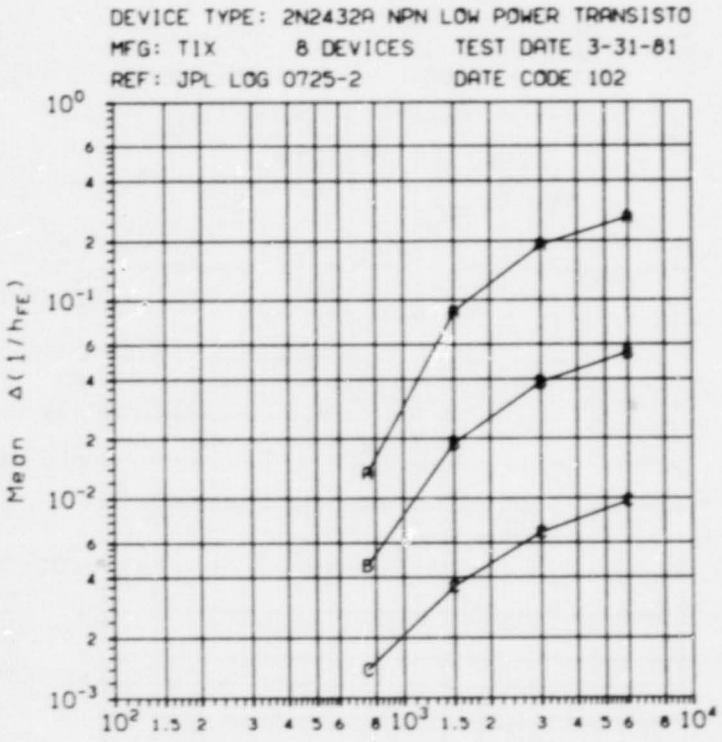
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	
A	.1000	10.0	.0004	.0316	.0739	
B	1.000	10.0	.0002	.0065	.0130	
C	10.00	10.0	.0002	.0012	.0019	

DEVICE TYPE: 2N2432A NPN LOW POWER TRANSISTO
MFG: TIX 8 DEVICES TEST DATE 3-31-81
REF: JPL LOG 0725-1 DATE CODE 102



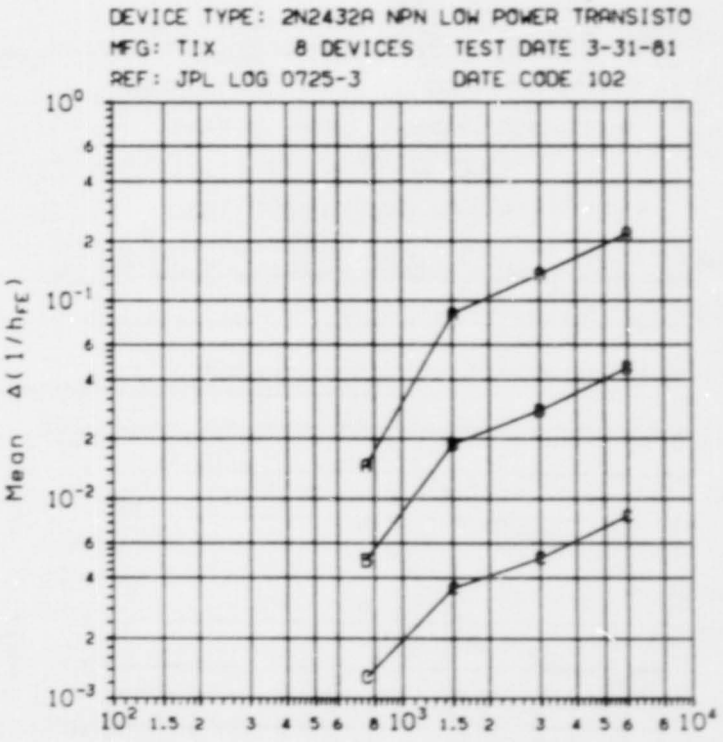
Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.1000	10.0	.0185	.0637	.0826	.0852
B	1.000	10.0	.0045	.0121	.0151	.0155
C	10.00	10.0	.0012	.0020	.0024	.0028



Δ(1/h_{FE}) VS DOSE

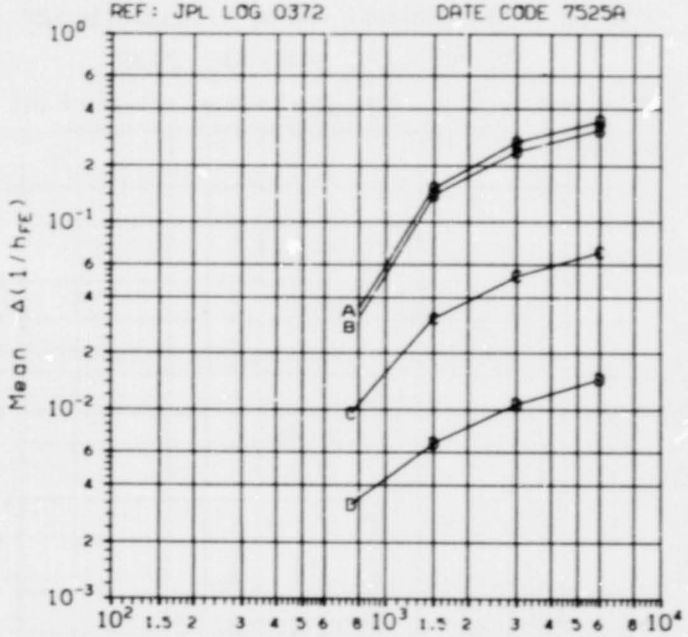
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.1000	10.0	.0084	.0598	.1065	.1429
B	1.000	10.0	.0027	.0109	.0167	.0219
C	10.00	10.0	.0007	.0017	.0023	.0031



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.1000	10.0	.0076	.0373	.0598	.0819
B	1.000	10.0	.0022	.0078	.0112	.0150
C	10.00	10.0	.0006	.0013	.0018	.0024

DEVICE TYPE: 2N2432 LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 5-18-79
REF: JPL LOG 0372 DATE CODE 7525A

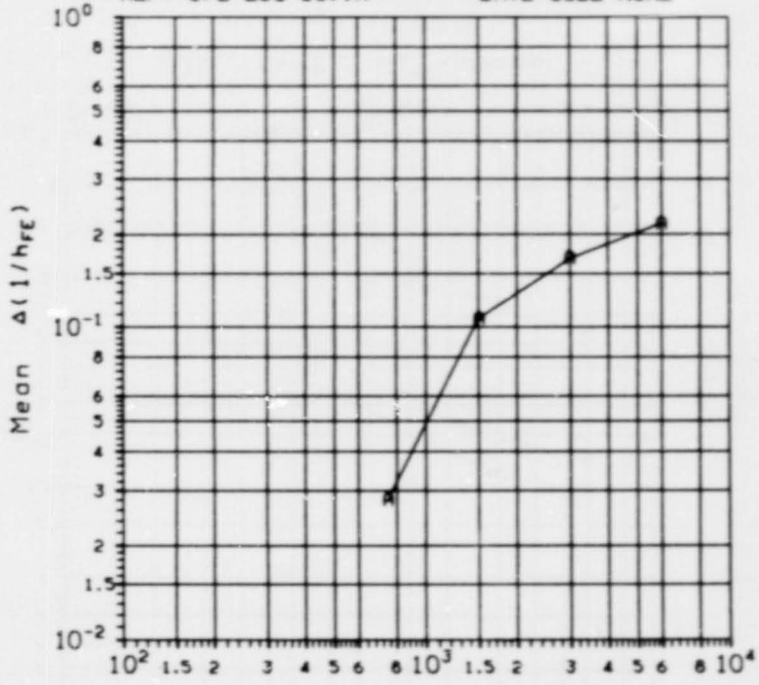


DOSE, Gy(Si) V MeV electrons

Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.1000	10.0	.0085	.0340	.0829	.1134
B	.1000	10.0	.0076	.0315	.0666	.1014
C	1.000	10.0	.0019	.0060	.0119	.0180
D	10.00	10.0	.0005	.0011	.0019	.0027

DEVICE TYPE: 2N2432 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 6-26-79
REF: JPL LOG 0399A DATE CODE NONE

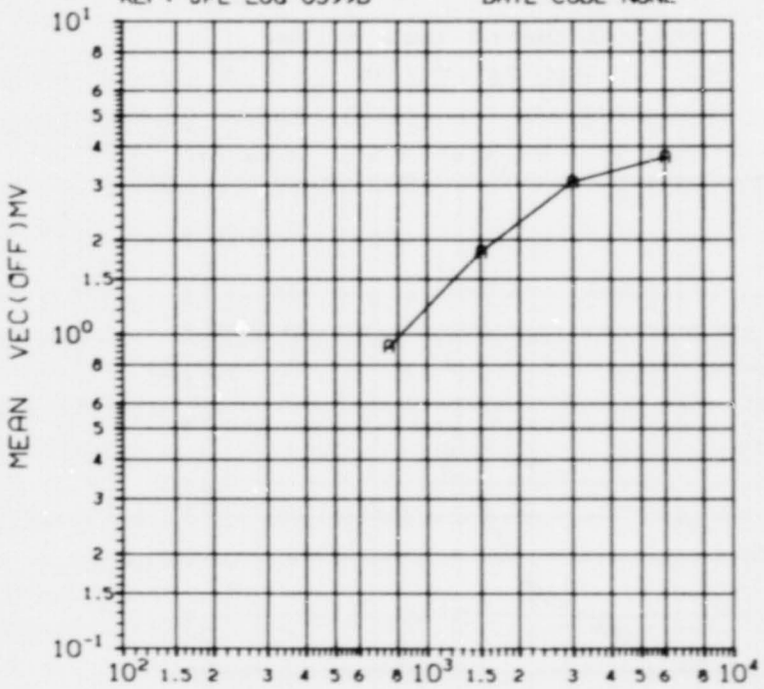


DOSE, Gy(Si) Co^{60} Gammas

Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (uA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	200.0	5.00	.0165	.0350	.0610	.0829

DEVICE TYPE: 2N2432 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 6-26-79
REF: JPL LOG 0399B DATE CODE NONE

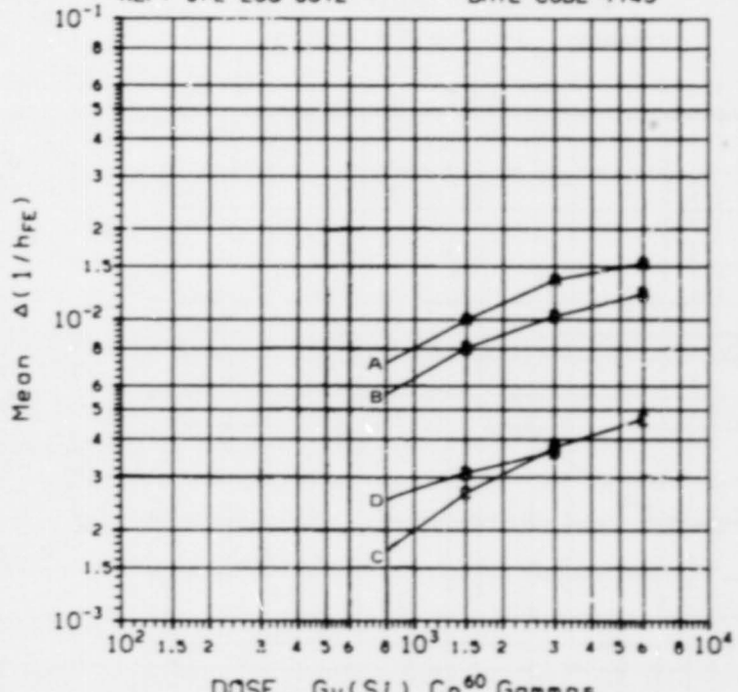


(2) VEC(OFFSET) IN MV; IB=200UA, IE= VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.1630	.2673	.8485	1.060

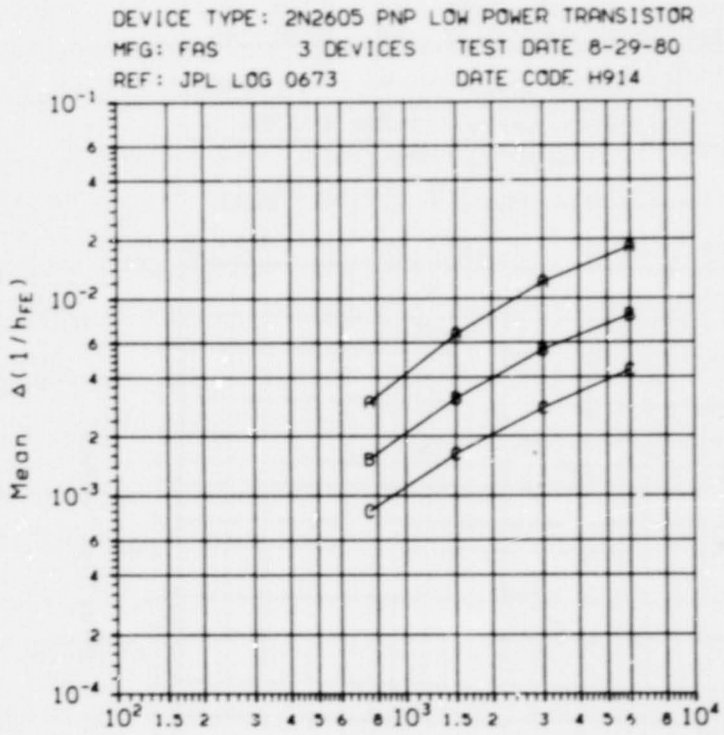
INITIAL MEAN VALUE VCE(OFF)MV = $5.82X10^{-1}$

DEVICE TYPE: 2N2484 NPN LOW POWER TRANSISTOR
MFG: FAS 3 DEVICES TEST DATE 8-4-80
REF: JPL LOG 0672 DATE CODE 7743



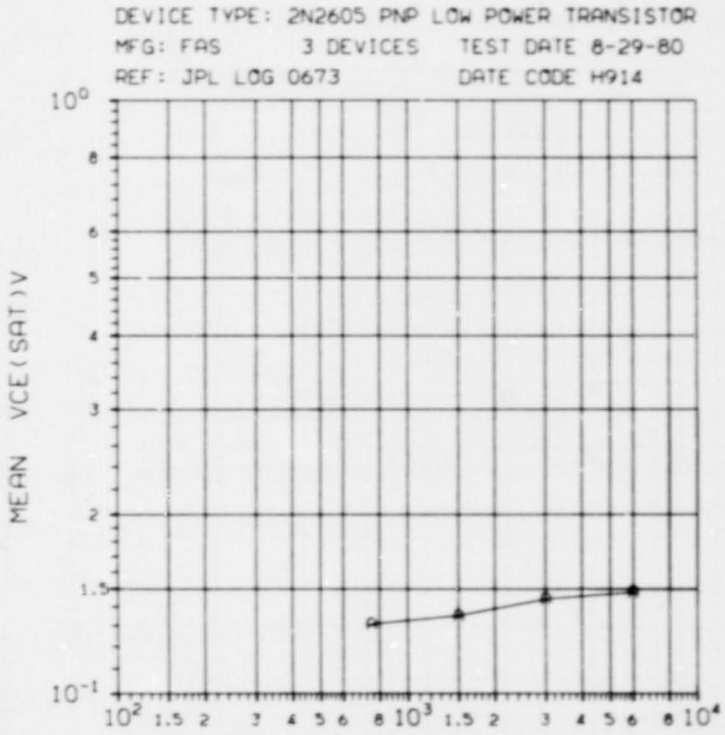
$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si)			
			.75	1.50	3.00	6.00
A	.0500	6.00	.0011	.0046	.0093	.0104
B	.1000	6.00	.0013	.0038	.0062	.0075
C	1.000	6.00	.0004	.0009	.0015	.0018
D	10.00	1.00	.0016	.0017	.0018	



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	6.00	.0011	.0018	.0028	.0041
B	.1000	6.00	.0005	.0008	.0010	.0013
C	1.000	6.00	.0002	.0003	.0004	.0005

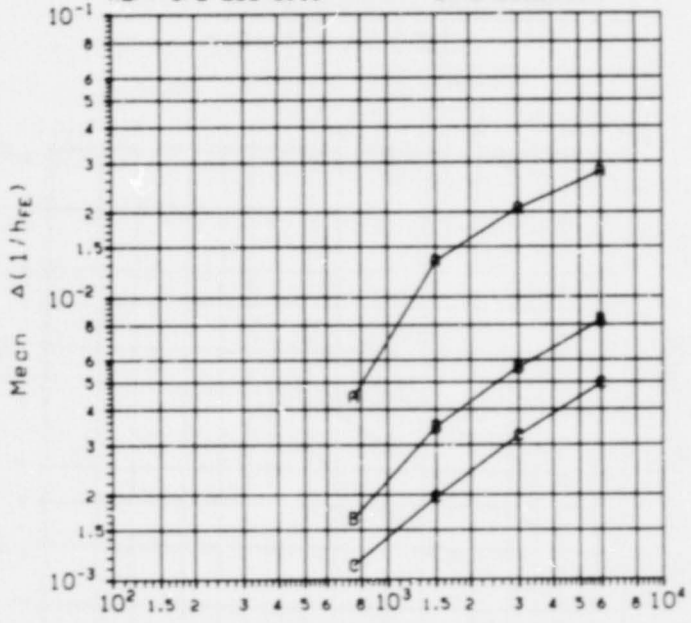


(4) VCE(SAT) IN VOLTS; IC=100UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0173	.0140	.0086	.0062

INITIAL MEAN VALUE VCE(SAT)V = 1.26×10^{-1}

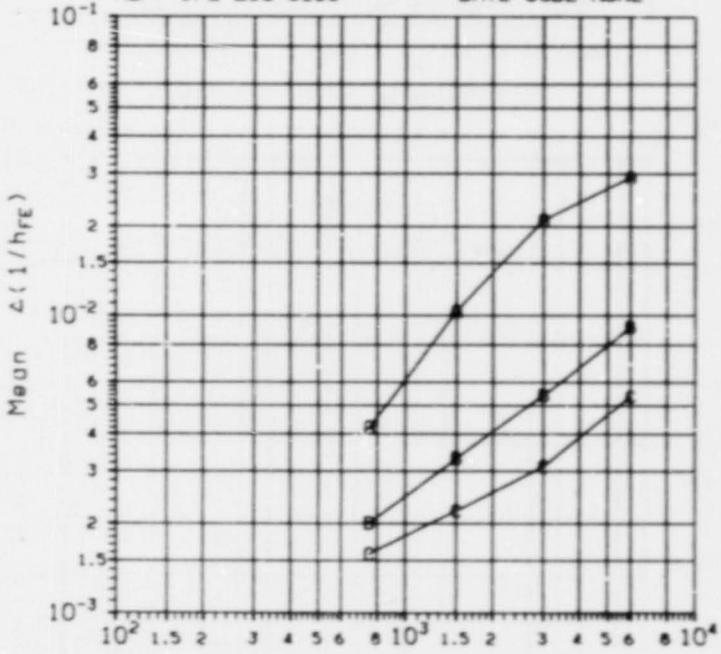
DEVICE TYPE: 2N2658 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 2-23-79
REF: JPL LOG 0313 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	20.00	.200	.0018	.0048	.0078	.0118
B	200.0	.200	.0002	.0007	.0014	.0020
C	500.0	.500	.0002	.0004	.0007	.0010

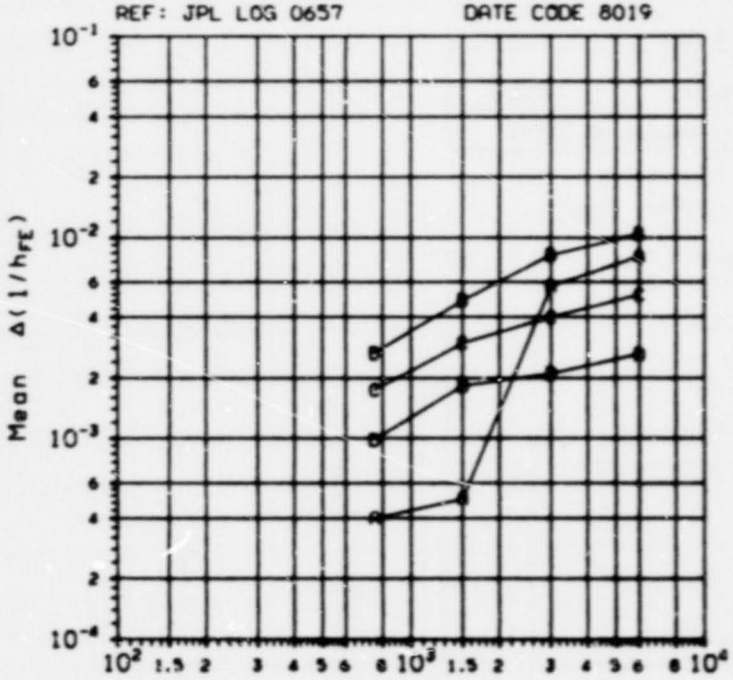
DEVICE TYPE: 2N2658 NPN POWER TRANSISTOR
MFG: SOD 6 DEVICES TEST DATE 4-18-79
REF: JPL LOG 0350 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	20.00	.200	.0009	.0029	.0042	.0054
B	200.0	.200	.0007	.0012	.0014	.0016
C	500.0	.500	.0003	.0005	.0006	.0007

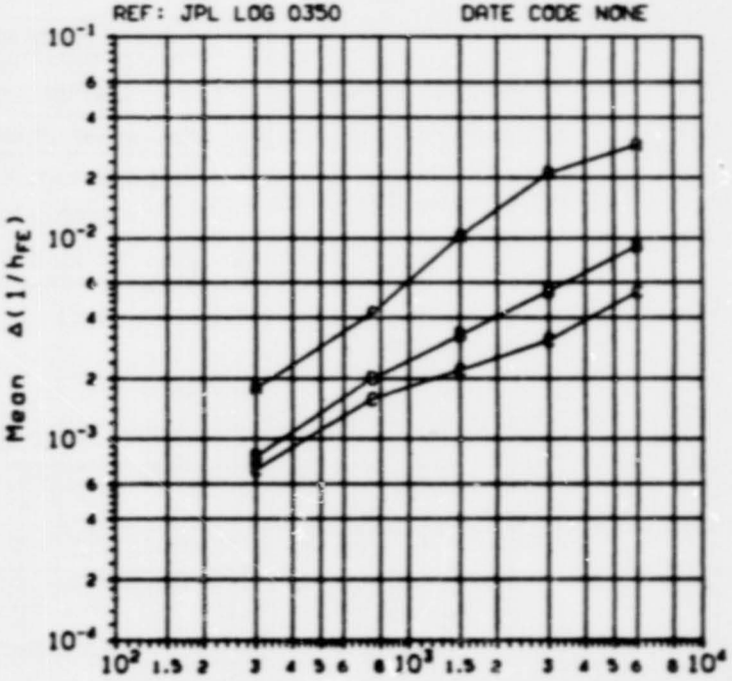
DEVICE TYPE: 2N2658 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 6-6-80
REF: JPL LOG 0657 DATE CODE 8019



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	20.00	.200	.0002	.0014	.0020	.0030
B	20.00	.200	.0003	.0009	.0020	.0028
C	200.0	.200	.0005	.0009	.0010	.0012
D	500.0	.500	.0003	.0006	.0006	.0006

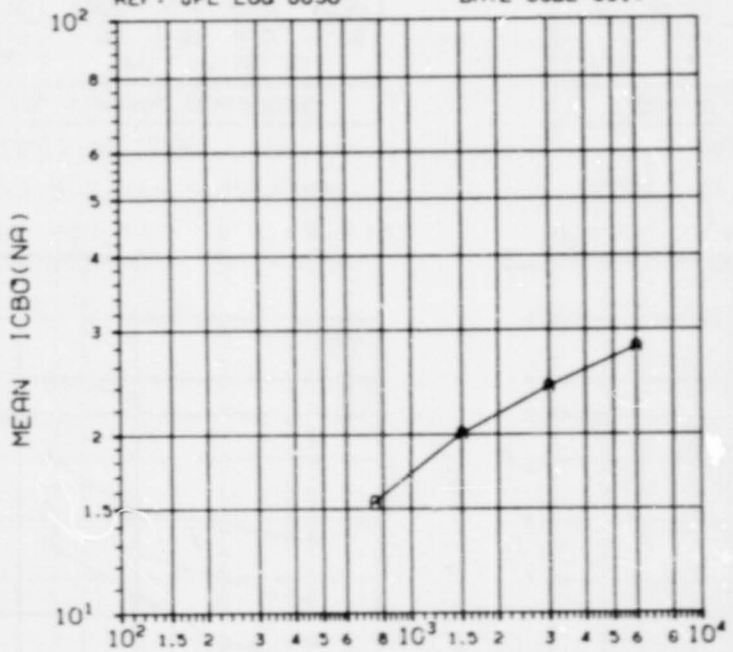
DEVICE TYPE: 2N2658 NPN POWER TRANSISTOR
MFG: SOD 6 DEVICES TEST DATE 4-18-79
REF: JPL LOG 0350 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .30	.75	1.50	3.00
A	20.00	.200	.0009	.0029	.0042	.00545
B	200.0	.200	.0007	.0012	.0014	.00165
C	500.0	.500	.0003	.0005	.0006	.00075

DEVICE TYPE: 2N2658 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 6-25-80
REF: JPL LOG 0658 DATE CODE 8019

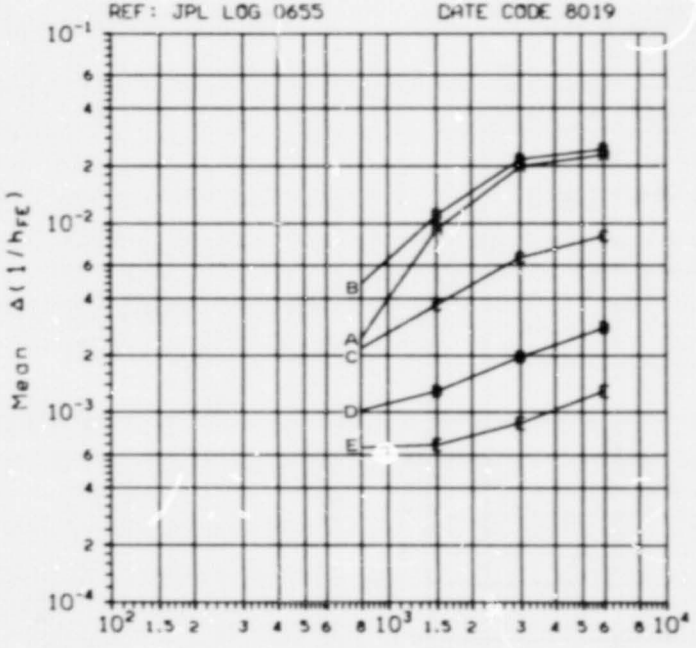


(1) ICBO IN NA; VCB=50V: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(SI)			
	.75	1.50	3.00	6.00
A	1.599	1.669	2.333	5.650

INITIAL MEAN VALUE ICBO(NA) = 5.84×10^0

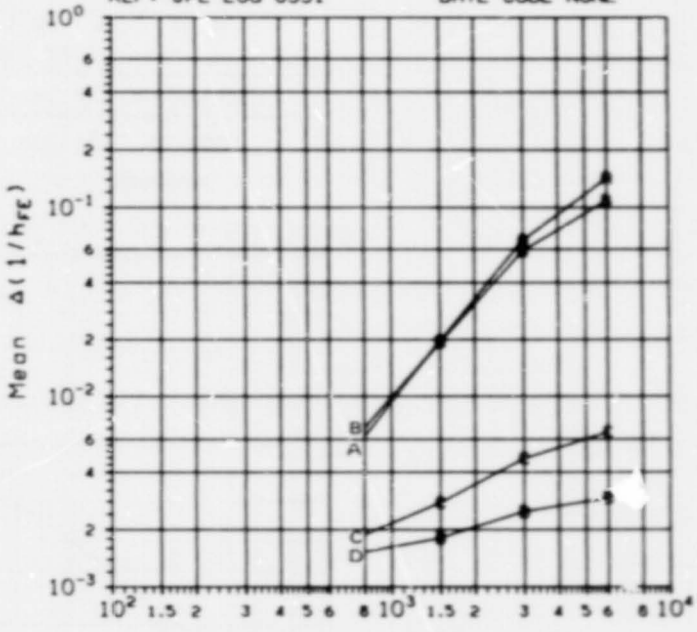
DEVICE TYPE: 2N2880 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 6-5-80
REF: JPL LOG 0655 DATE CODE 8019



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.000	4.00	.0007	.0025	.0023	.0076
B	1.000	4.00	.0007	.0024	.0019	.0086
C	10.00	4.00	.0002	.0006	.0006	.0018
D	100.0	4.00	.0001	.0001	.0002	.0003
E	1000.	4.00	.0001	.0001	.0001	.0001

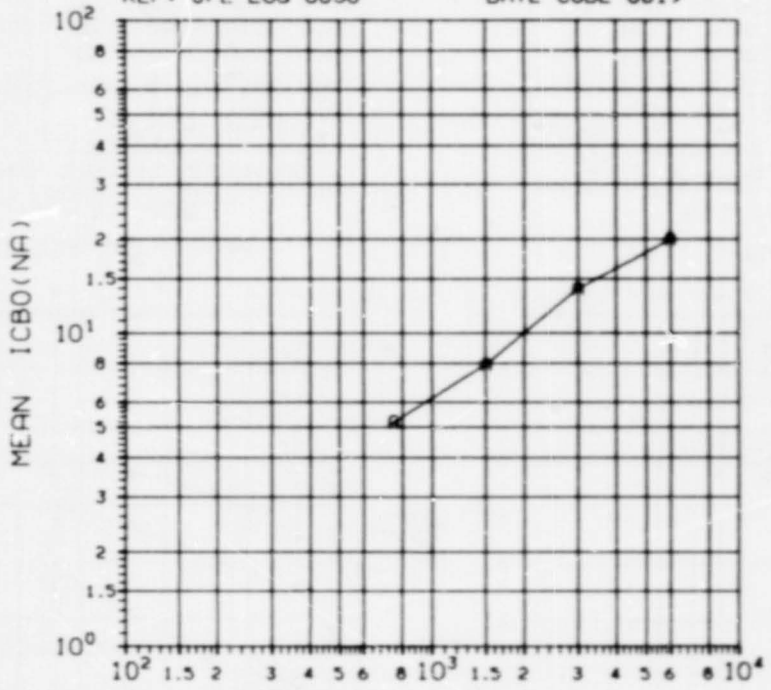
DEVICE TYPE: 2N2880 NPN POWER TRANSISTOR
MFG: SOD 6 DEVICES TEST DATE 4-24-79
REF: JPL LOG 0351 DATE CODE NONE



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.000	4.00	.0019	.0055	.0156	.0501
B	1.000	4.00	.0016	.0046	.0129	.0400
C	100.0	2.00	.0003	.0004	.0004	.0008
D	1000.	2.00	.0004	.0006	.0006	.0006

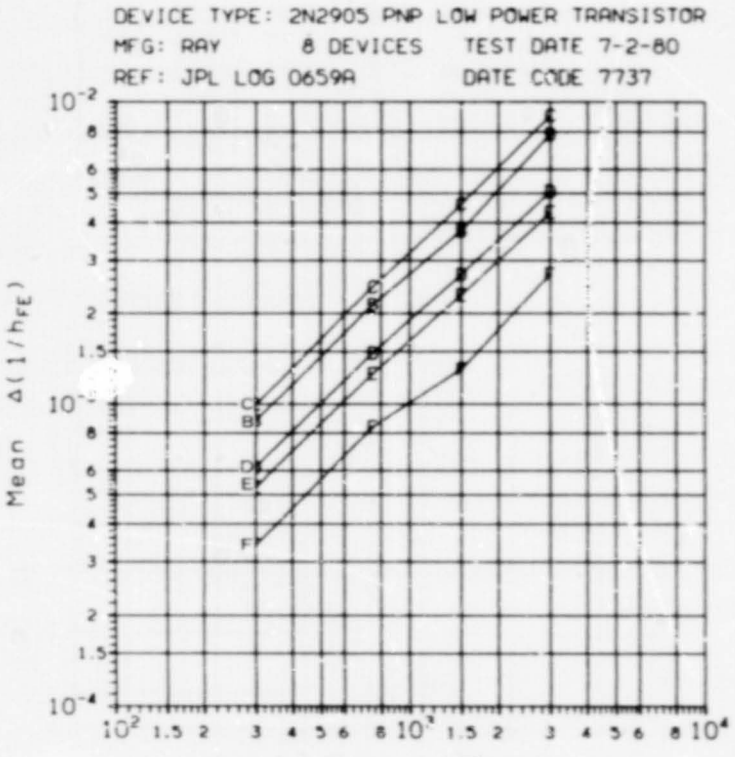
DEVICE TYPE: 2N2880 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 6-23-80
REF: JPL LOG 0656 DATE CODE 8019



(1) ICBO IN NA; VCE=10V VS DOSE

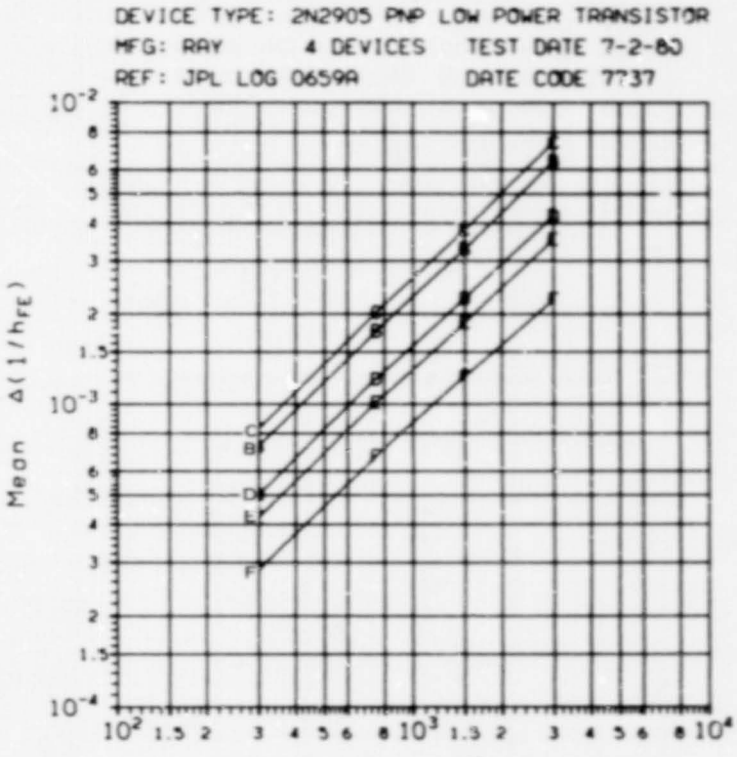
TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	1.006	2.823	5.44[illegible]	11.08

INITIAL MEAN VALUE ICBO(NA) = $2.41X10^0$



Δ(1/h_{FE}) VS DOSE

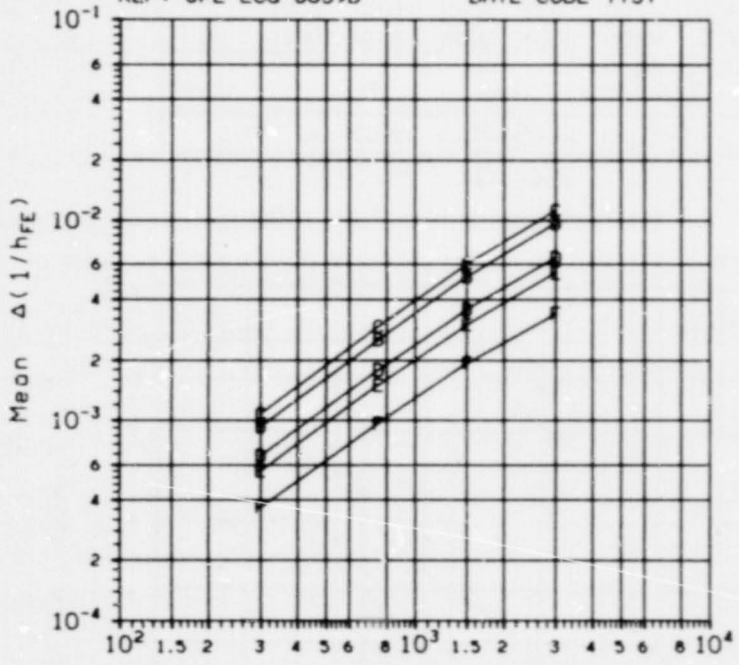
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .30	.75	1.50	3.00
B	.1000	20.0	.0003	.0006	.0013	.0024
C	.1000	.500	.0003	.0007	.0013	.0026
D	1.000	.500	.0002	.0004	.0007	.0014
E	1.000	20.0	.0002	.0004	.0007	.0013
F	10.00	20.0	.0001	.0002	.0004	.0008



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .30	.75	1.50	3.00
B	.1000	20.0	.0002	.0004	.0007	.0014
C	.1000	.500	.0002	.0004	.0007	.0014
D	1.000	.500	.0001	.0002	.0004	.0007
E	1.000	20.0	.0001	.0002	.0004	.0007
F	10.00	20.0	.0001	.0001	.0002	.0004

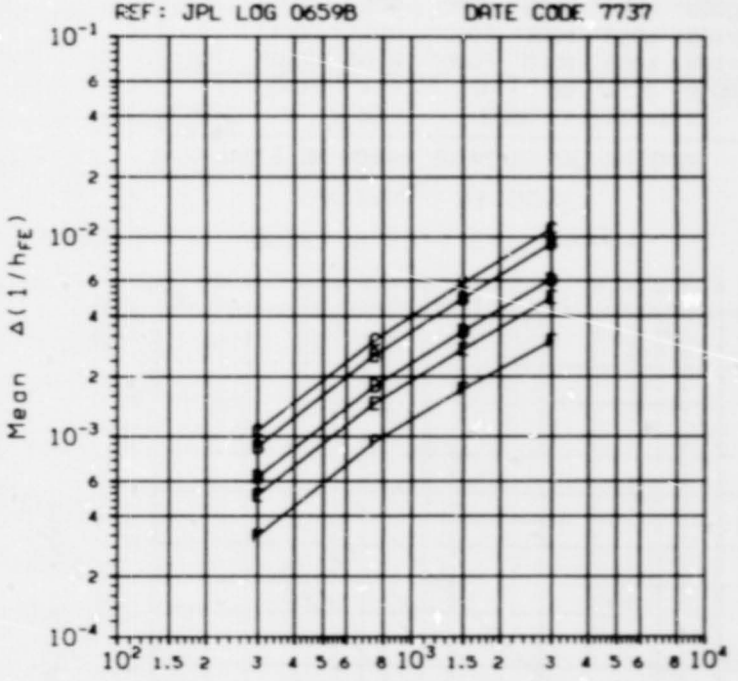
DEVICE TYPE: 2N2905 PNP LOW POWER TRANSISTOR
MFG: RAY 6 DEVICES TEST DATE 7-8-80
REF: JPL LOG 0659B DATE CODE 7737



$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .30	.75	1.50	3.00
B	.1000	20.0	.0003	.0009	.0019	.0035
C	.1000	.500	.0004	.0010	.0020	.0037
D	1.000	.500	.0002	.0006	.0011	.0019
E	1.000	20.0	.0002	.0005	.0010	.0018
F	10.00	20.0	.0002	.0004	.0007	.0010

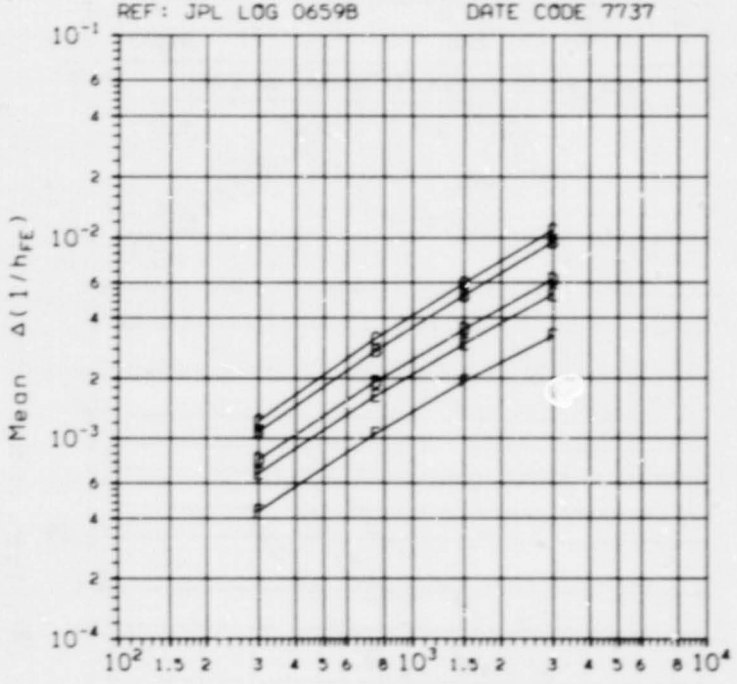
DEVICE TYPE: 2N2905 PNP LOW POWER TRANSISTOR
MFG: RAY 6 DEVICES TEST DATE 7-8-80
REF: JPL LOG 0659B DATE CODE 7737



$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .30	.75	1.50	3.00
B	.1000	20.0	.0003	.0007	.0013	.0024
C	.1000	.500	.0003	.0008	.0014	.0026
D	1.000	.500	.0002	.0005	.0009	.0015
E	1.000	20.0	.0002	.0005	.0008	.0014
F	10.00	20.0	.0001	.0003	.0005	.0009

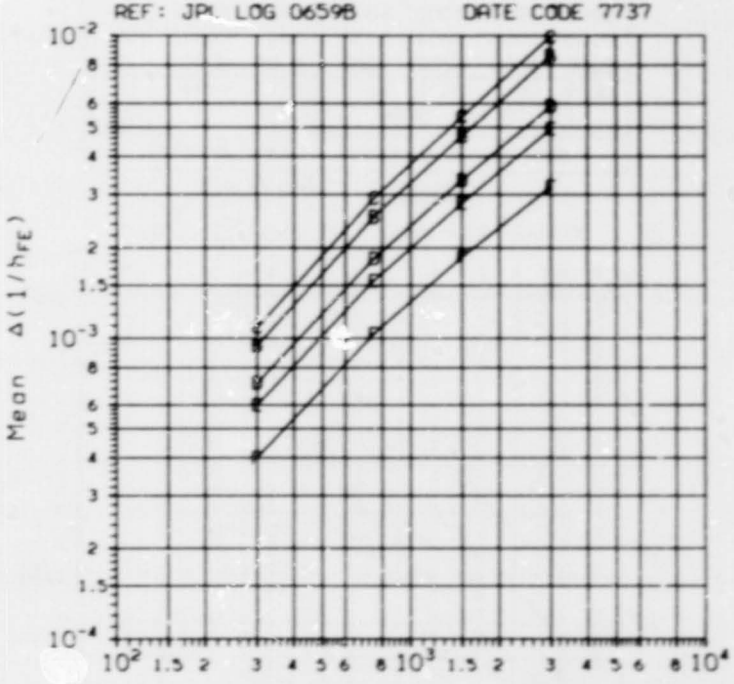
DEVICE TYPE: 2N2905 PNP LOW POWER TRANSISTOR
MFG: RAY 8 DEVICES TEST DATE 7-8-80
REF: JPL LOG 0659B DATE CODE 7737



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .30	.75	1.50	3.00
B	.1000	20.0	.0003	.0008	.0016	.0027
C	.1000	.500	.0003	.0009	.0016	.0028
D	1.000	.500	.0002	.0005	.0009	.0014
E	1.000	20.0	.0002	.0005	.0008	.0013
F	10.00	20.0	.0001	.0003	.0005	.0008

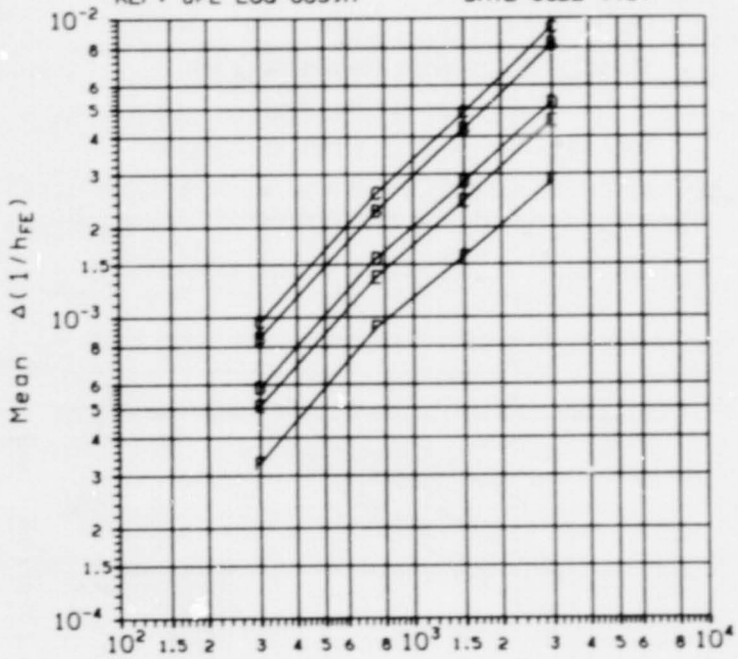
DEVICE TYPE: 2N2905 PNP LOW POWER TRANSISTOR
MFG: RAY 4 DEVICES TEST DATE 7-8-80
REF: JPL LOG 0659B DATE CODE 7737



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .30	.75	1.50	3.00
B	.1000	20.0	.0000	.0002	.0003	.0004
C	.1000	.500	.0000	.0002	.0003	.0005
D	1.000	.500	.0000	.0001	.0002	.0002
E	1.000	20.0	.0000	.0001	.0001	.0002
F	10.00	20.0	.0000	.0001	.0001	.0001

DEVICE TYPE: 2N2905 PNP LOW POWER TRANSISTOR
MFG: RAY 8 DEVICES TEST DATE 7-2-80
REF: JPL LOG 0659A DATE CODE 7737

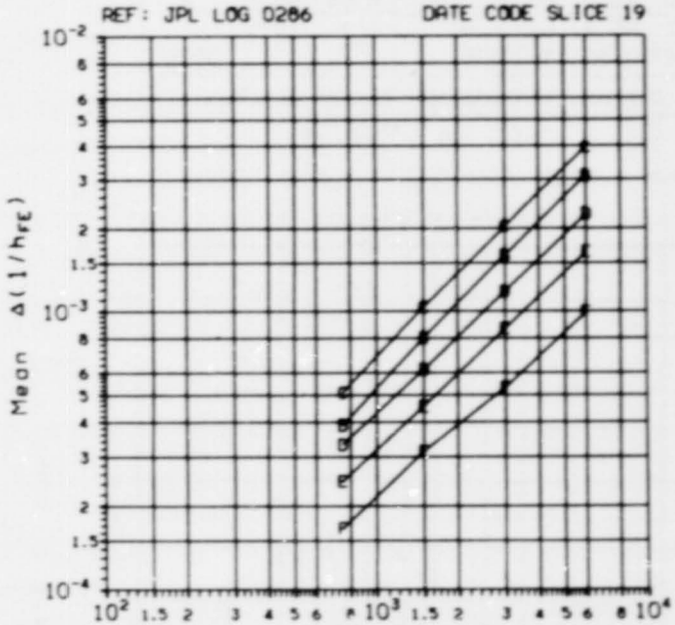


DOSE, Gy(Si) Co^{60} Gammas

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .30	.75	1.50	3.00
B	.1000	20.0	.0002	.0005	.0010	.0021
C	.1000	.500	.0002	.0005	.0010	.0022
D	1.000	.500	.0001	.0003	.0006	.0012
E	1.000	20.0	.0001	.0003	.0006	.0011
F	10.00	20.0	.0001	.0002	.0004	.0007

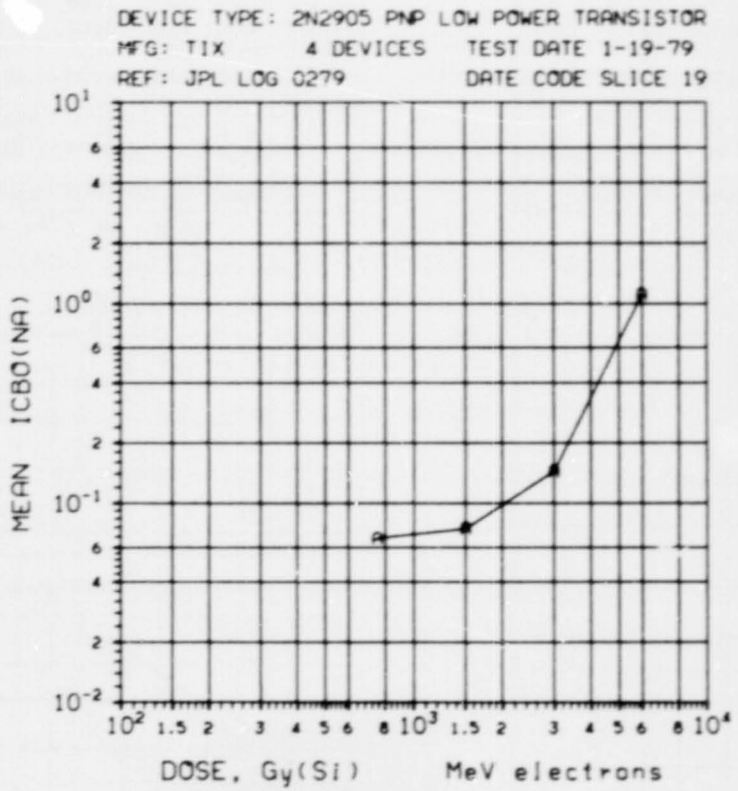
DEVICE TYPE: 2N2905 PNP LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 1-17-79
REF: JPL LOG 0286 DATE CODE SLICE 19



DOSE, Gy(Si) 2.5 MeV electrons

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0001	.0001	.0002	.0003
C	.1000	.500	.0001	.0001	.0002	.0004
D	1.000	.500	.0001	.0001	.0001	.0002
E	1.000	20.0	.0001	.0001	.0001	.0001
F	10.00	20.0	.0000	.0000	.0001	.0001

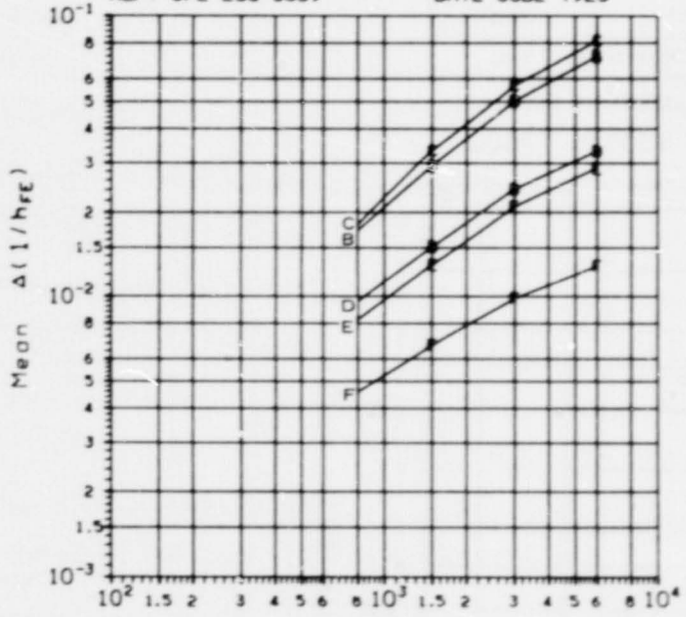


(1) ICBO IN NANOAMPS (VCE = 50V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0056	.0090	.0312	.4665

INITIAL MEAN VALUE ICBO(NA) = 6.35×10^{-2}

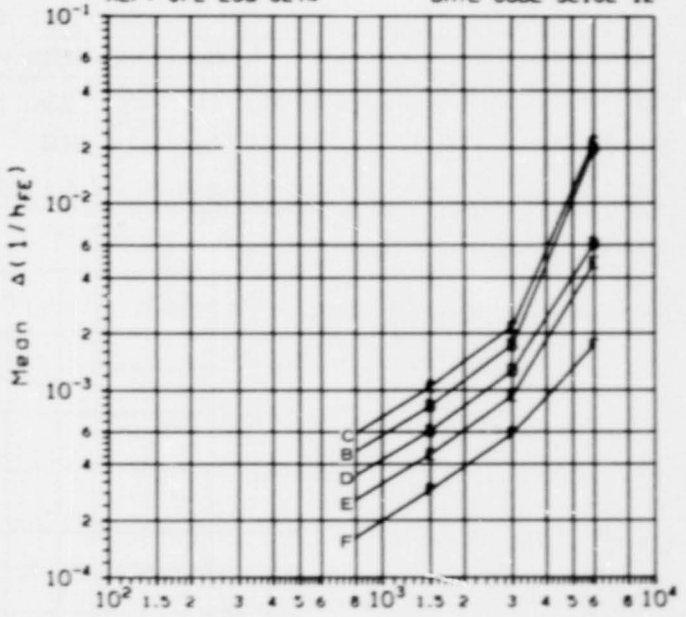
DEVICE TYPE: 2N2907 PNP LOW POWER TRANSISTOR
MFG: FAS 3 DEVICES TEST DATE 4-10-80
REF: JPL LOG 0609 DATE CODE 7925



Δ(1/h_{FE}) VS DOSE

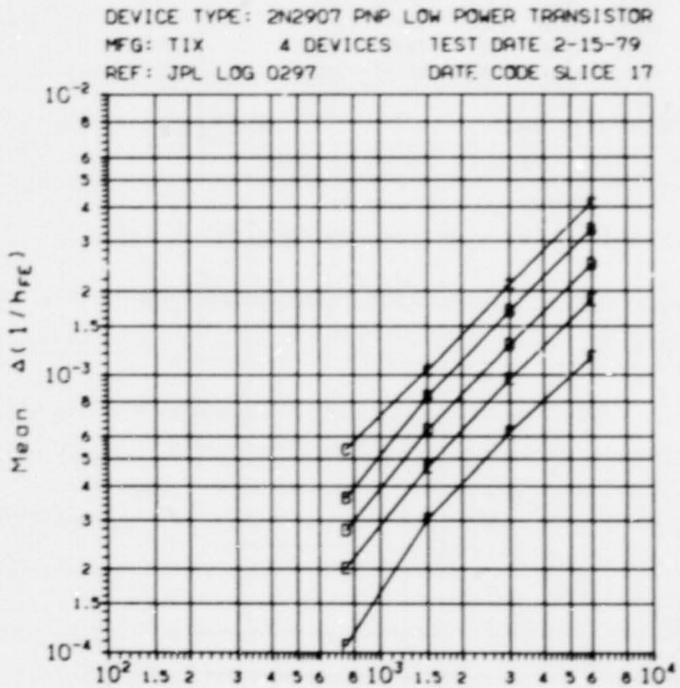
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0026	.0041	.0049	.0060
C	.1000	.500	.0032	.0048	.0055	.0063
D	1.000	.500	.0014	.0020	.0024	.0030
E	1.000	20.0	.0012	.0017	.0022	.0028
F	10.00	20.0	.0007	.0007	.0012	.0015

DEVICE TYPE: 2N2907 PNP LOW POWER TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 1-12-79
REF: JPL LOG 0274 DATE CODE SLICE 12



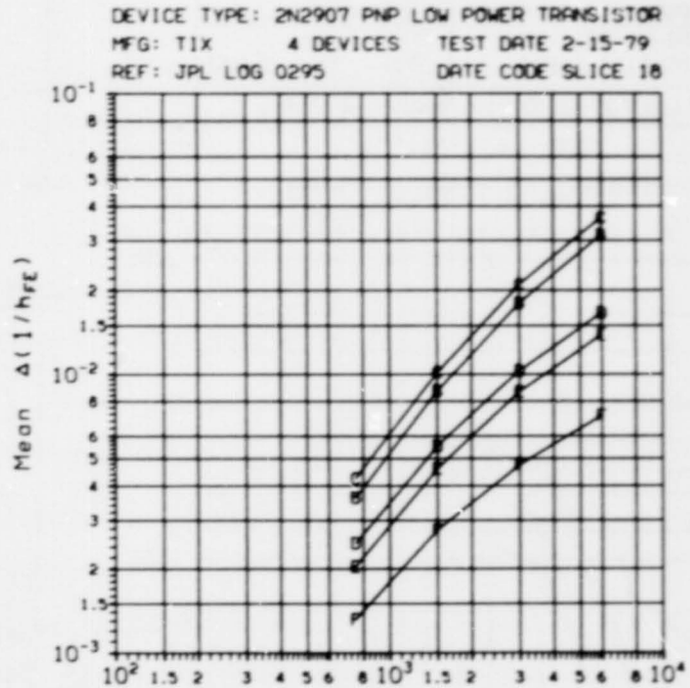
Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0002	.0001	.0002	.0422
C	.1000	.500	.0003	.0002	.0002	.0446
D	1.000	.500	.0001	.0001	.0001	.0102
E	1.000	20.0	.0001	.0001	.0001	.0083
F	10.00	20.0	.0001	.0000	.0001	.0021



Δ(1/h_{FE}) VS DOSE

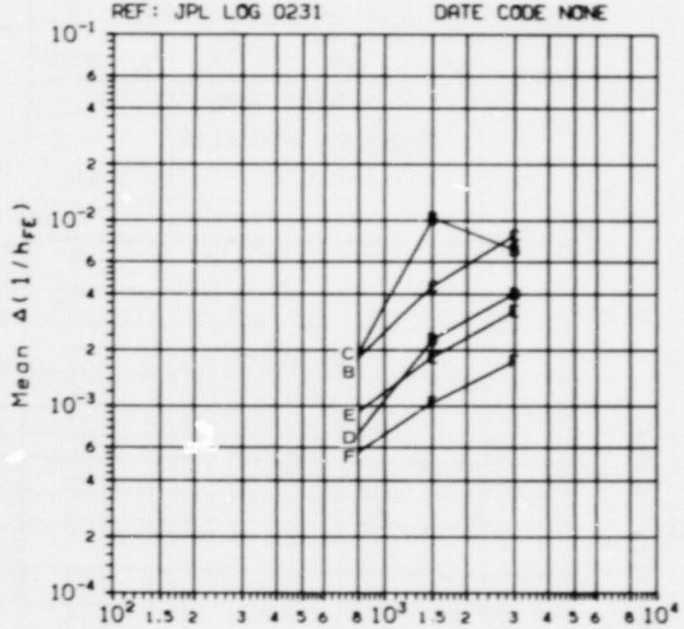
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0001	.0001	.0002	.0003
C	.1000	.500	.0001	.0001	.0002	.0003
D	1.000	.500	.0000	.0000	.0001	.0002
E	1.000	20.0	.0000	.0000	.0001	.0002
F	10.00	20.0	.0000	.0000	.0000	.0001



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0003	.0007	.0015	.0024
C	.1000	.500	.0004	.0009	.0016	.0027
D	1.000	.500	.0002	.0004	.0007	.0012
E	1.000	20.0	.0002	.0004	.0007	.0010
F	10.00	20.0	.0001	.0002	.0003	.0004

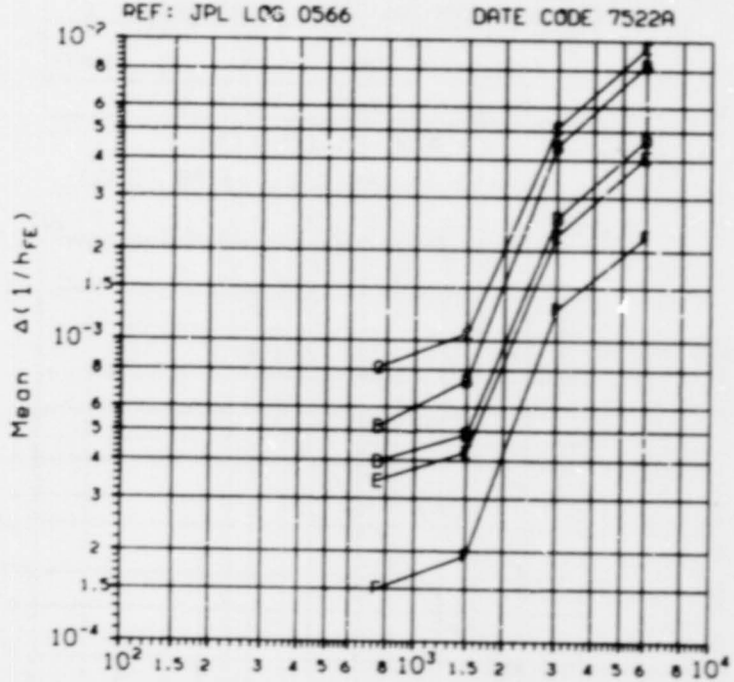
DEVICE TYPE: 2N2907 PNP LOW POWER TRANSISTOR
MFG: TIX 5 DEVICES TEST DATE 11-1-78
REF: JPL LOG 0231 DATE CODE NONE



$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
B	.1000	20.0	.0025	.0145	.0110
C	.1000	.500	.0032	.0070	.0130
D	1.000	.500	.0022	.0034	.0058
E	1.000	20.0	.0014	.0029	.0049
F	10.00	20.0	.0008	.0016	.0024

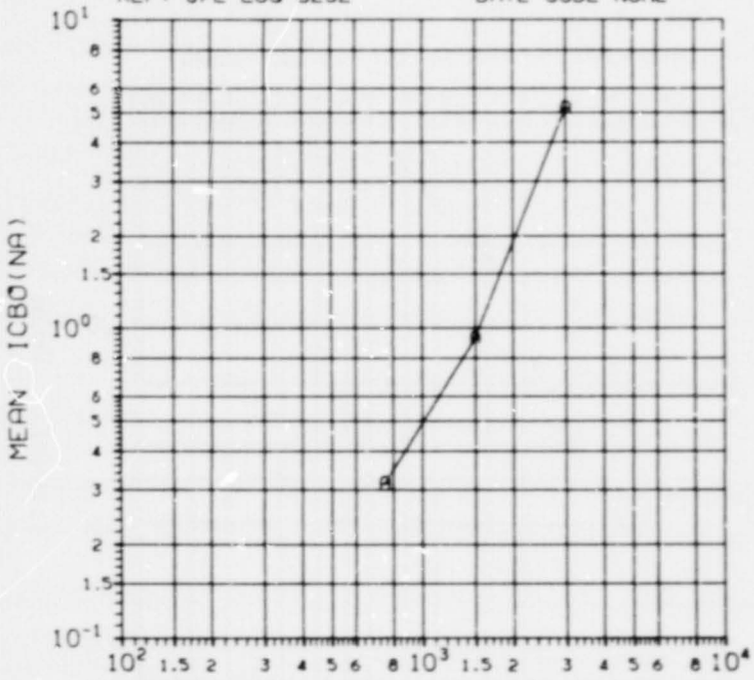
DEVICE TYPE: 2N2907 PNP LOW POWER TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 12-7-79
REF: JPL LOG 0566 DATE CODE 7522A



$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0009	.0005	.0058	.0109
C	.1000	.500	.0012	.0005	.0066	.0123
D	1.000	.500	.0007	.0003	.0033	.0056
E	1.000	20.0	.0006	.0003	.0029	.0050
F	10.00	20.0	.0004	.0002	.0017	.0025

DEVICE TYPE: 2N2907 PNP LOW POWER TRANSISTOR
MFG: TIX 5 DEVICES TEST DATE 11-3-78
REF: JPL LOG 0232 DATE CODE NONE

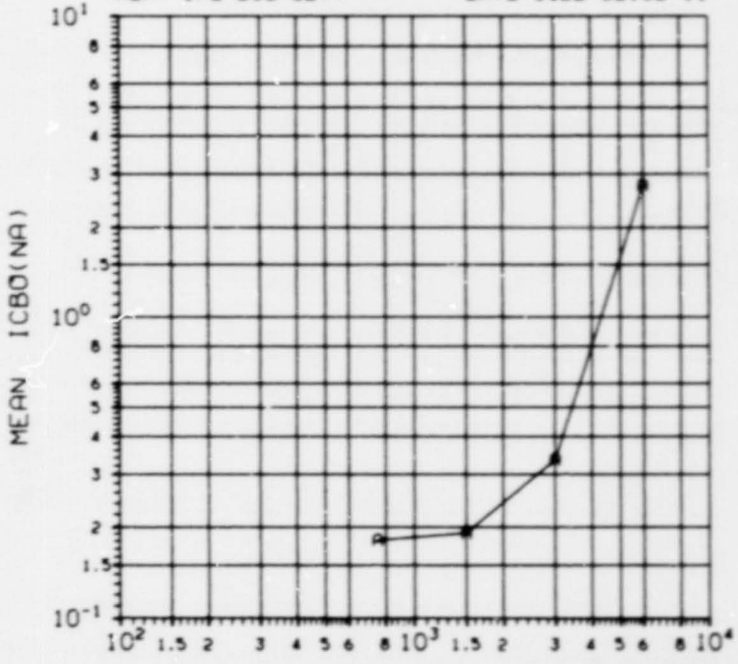


(1) ICBO, VCB=-50V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kiloGy(Si) .75 1.50 3.00
A	.1067 .6569 4.537

INITIAL MEAN VALUE ICBO(NA) = 2.76×10^{-1}

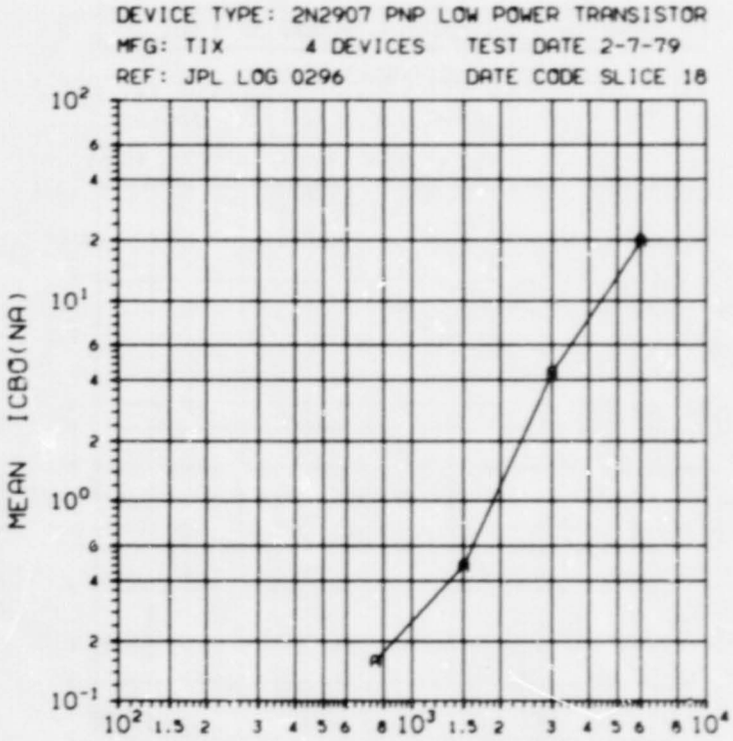
DEVICE TYPE. 2N2907 PNP LOW POWER TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 1-18-79
REF: JPL LOG 0277 DATE CODE SLICE 11



(1) ICBO IN NANOAMPS (VCE=50V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kiloGy(Si) .75 1.50 3.00 6.00
A	.0256 .0243 .1167 1.924

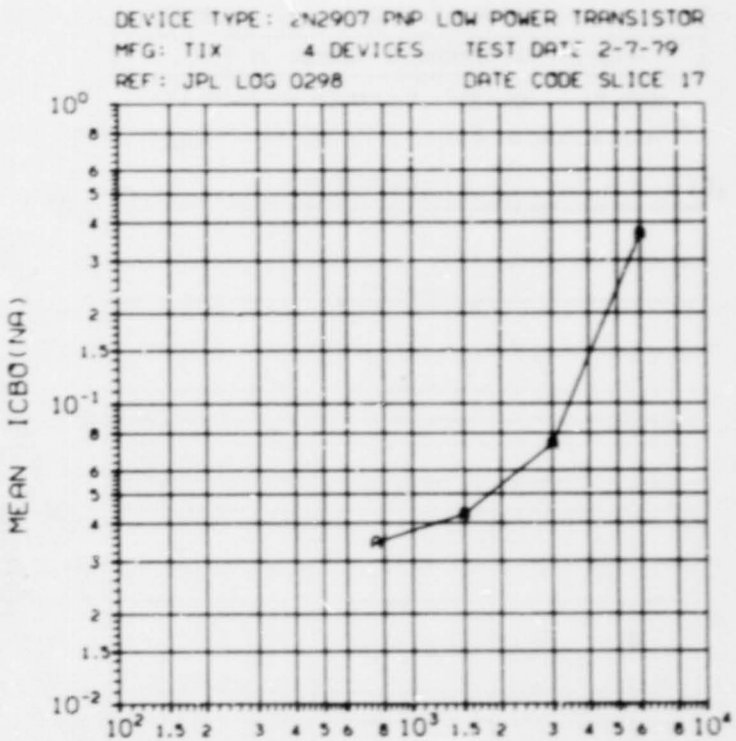
INITIAL MEAN VALUE ICBO(NA) = 2.28×10^{-1}



(1) ICBO IN NANOAMPS (VCB = 50V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0636	.2755	3.026	13.24

INITIAL MEAN VALUE ICBO(NA) = 1.57×10^{-1}

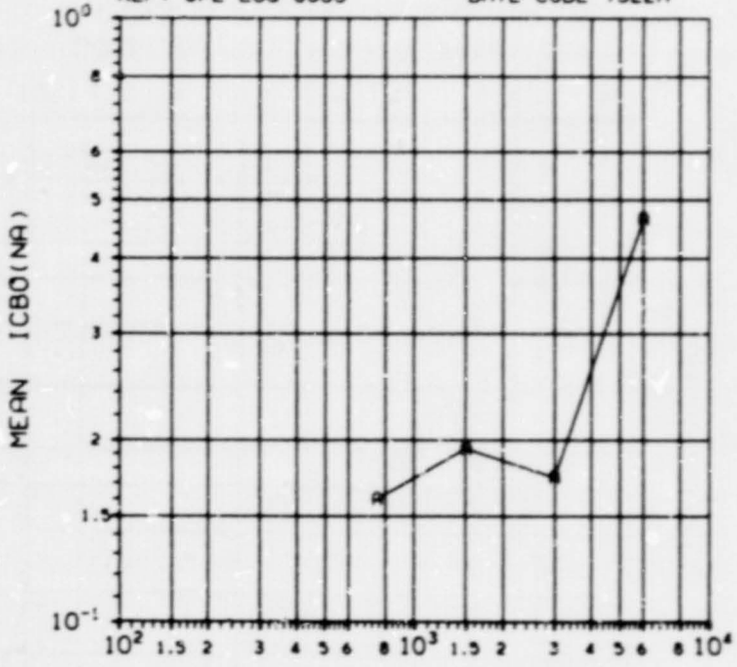


(1) ICBO IN NANOAMPS (VCB = 50V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0021	.0032	.0066	.0951

INITIAL MEAN VALUE ICBO(NA) = 8.75×10^{-2}

DEVICE TYPE: 2N2907 PNP LOW POWER TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 12-10-79
REF: JPL LOG 0563 DATE CODE 7522A



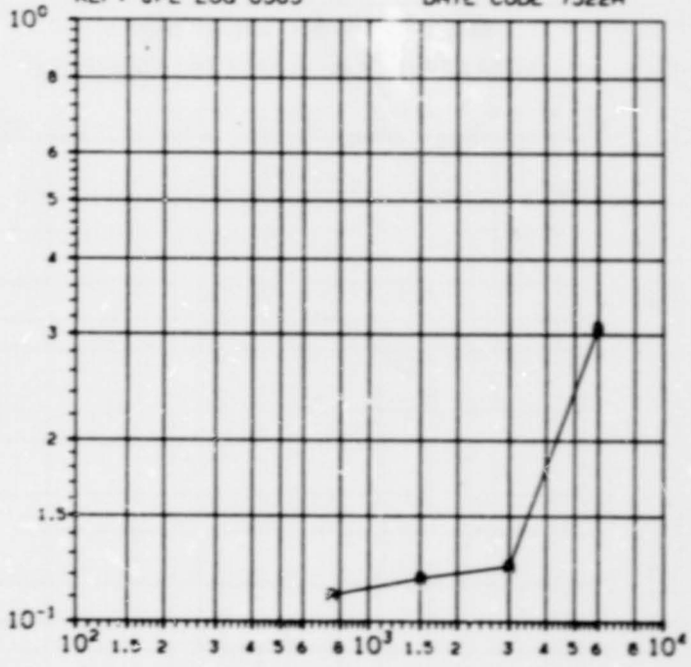
DOSE, Gy(Si) Co^{60} Gammas

(1) ICBO IN NA; VCB=-40V VS DOSE

TABLE OF NORMAL STANDARD DEV'ATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0391	.0534	.0442	.0726

INITIAL MEAN VALUE ICBO(NA) = 1.76×10^{-1}

DEVICE TYPE: 2N2907 PNP LOW POWER TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 12-10-79
REF: JPL LOG 0565 DATE CODE 7522A



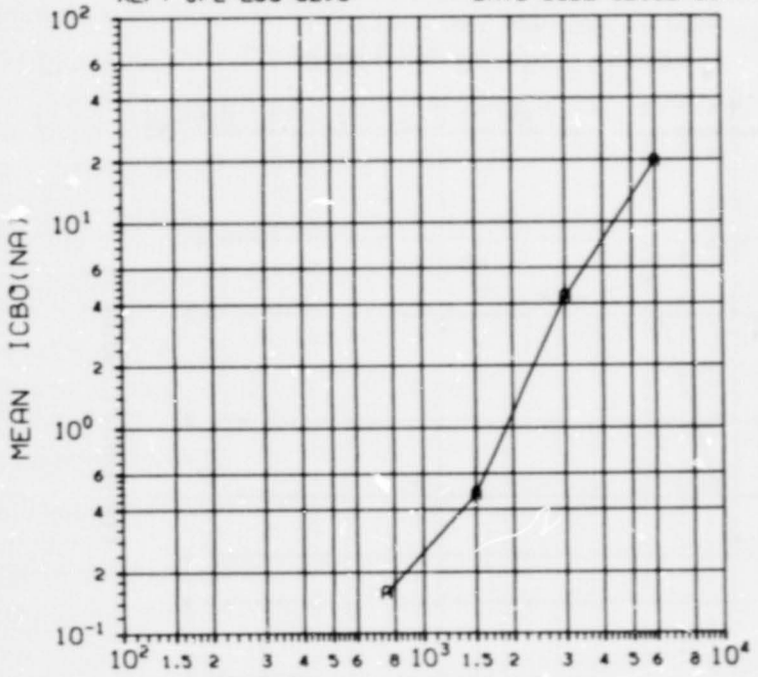
DOSE, Gy(Si) Co^{60} Gammas

(1) ICBO IN NA; VCB=-40V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0169	.0168	.0175	.0475

INITIAL MEAN VALUE ICBO(NA) = 1.27×10^{-1}

DEVICE TYPE: 2N2907 PNP LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 2-7-79
REF: JPL LOG 0296 DATE CODE SLICE 18



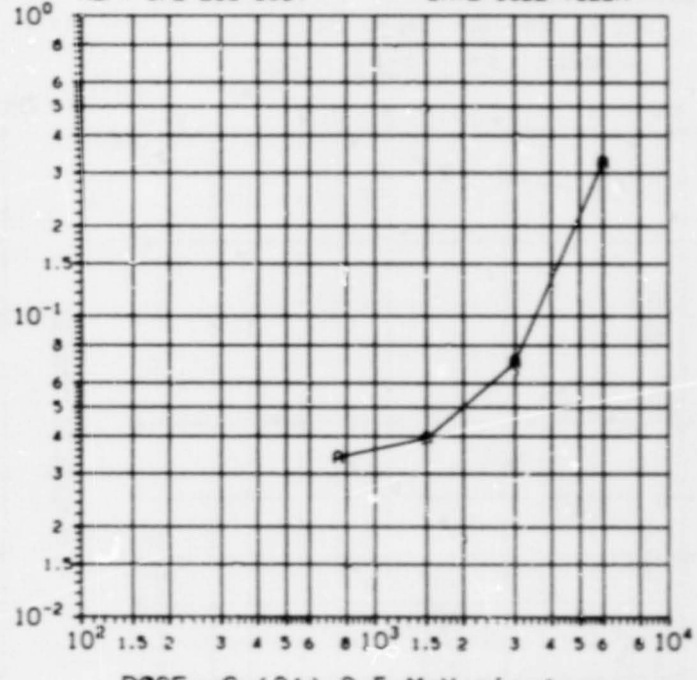
DOSE, Gy(Si) 2.5 MeV electrons

(1) ICBO IN NANOAMPS (VCB = 50V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0636	.2755	3.026	13.24

INITIAL MEAN VALUE ICBO(NA) = 1.57×10^{-1}

DEVICE TYPE: 2N2907 PNP LOW POWER TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 12-6-79
REF: JPL LOG 0567 DATE CODE 7522A



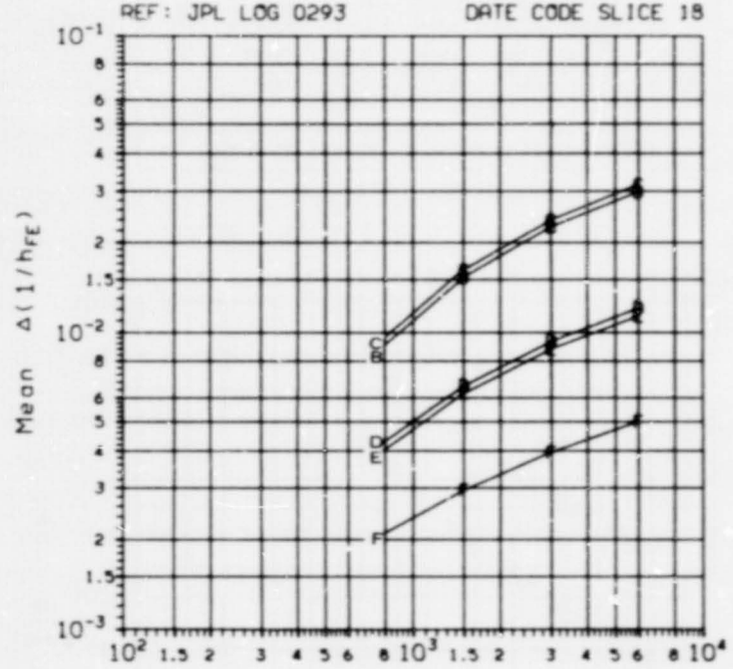
DOSE, Gy(Si) 2.5 MeV electrons

(1) ICBO IN NA; VCB=-40V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0183	.0189	.0308	.1412

INITIAL MEAN VALUE ICBO(NA) = 4.92×10^{-2}

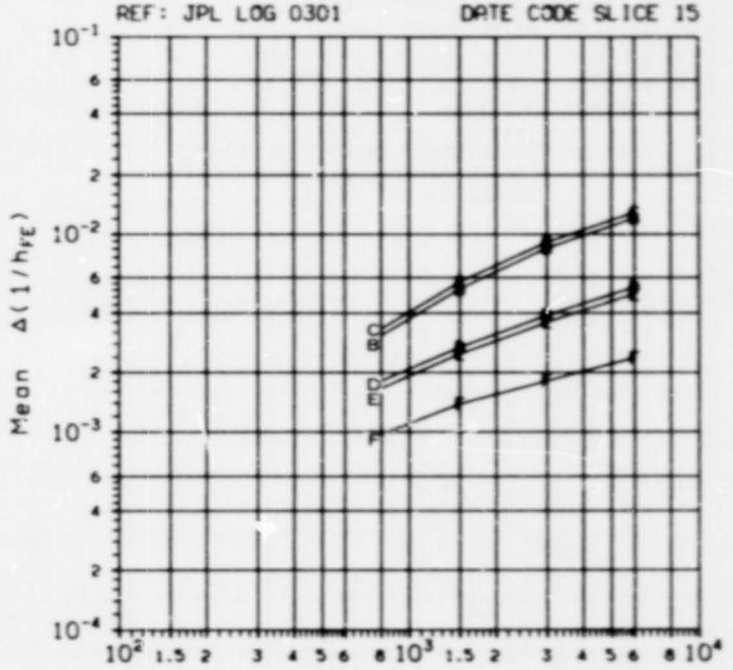
DEVICE TYPE: 2N2920 DUAL NPN TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 2-16-79
REF: JPL LOG 0293 DATE CODE SLICE 18



Δ(1/hFE) VS DOSE

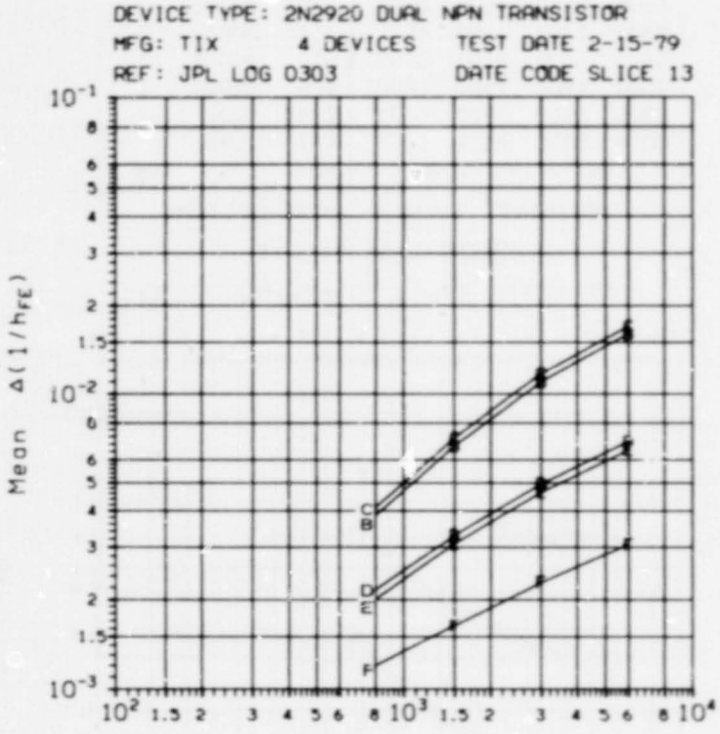
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0025	.0042	.0057	.0067
C	.1000	.500	.0027	.0044	.0061	.0070
D	1.000	.500	.0010	.0016	.0021	.0025
E	1.000	20.0	.0010	.0015	.0020	.0023
F	10.00	20.0	.0004	.0006	.0008	.0009

DEVICE TYPE: 2N2920 DUAL NPN TRANSISTOR
MFG: TIX 3 DEVICES TEST DATE 2-15-79
REF: JPL LOG 0301 DATE CODE SLICE 15



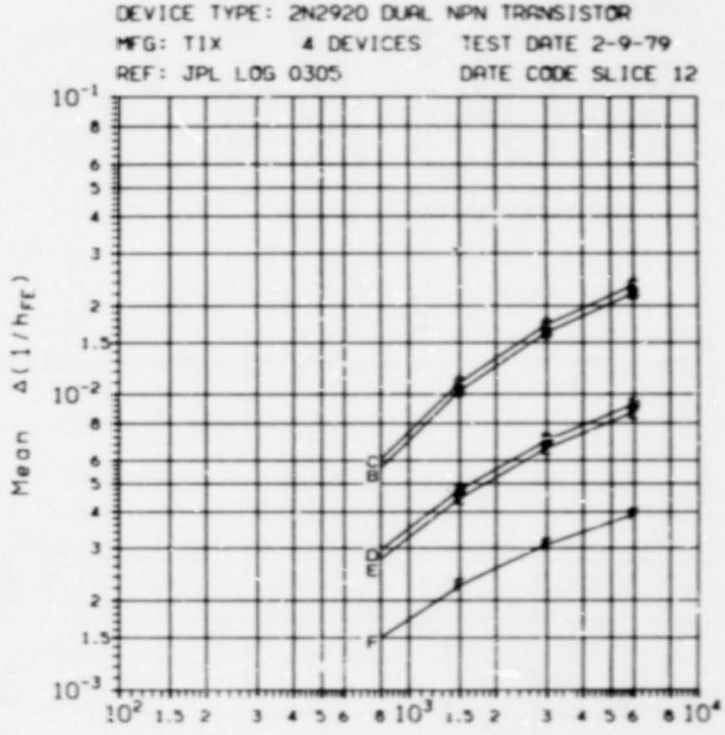
Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0013	.0028	.0049	.0069
C	.1000	.500	.0014	.0029	.0052	.0073
D	1.000	.500	.0006	.0012	.0019	.0026
E	1.000	20.0	.0006	.0011	.0018	.0024
F	10.00	20.0	.0003	.0005	.0007	.0009



Δ(1/h_{FE}) VS DOSE

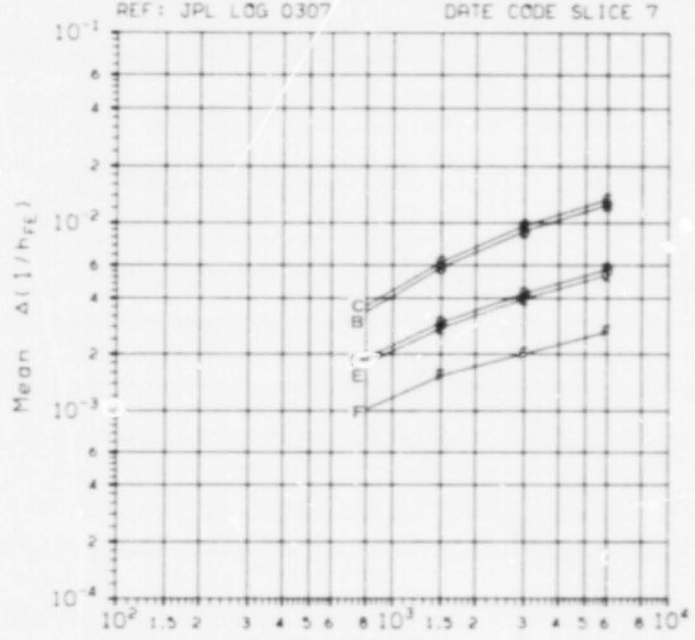
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0019	.0037	.0062	.0092
C	.1000	.500	.0020	.0039	.0066	.0097
D	1.000	.500	.0009	.0015	.0024	.0034
E	1.000	20.0	.0008	.0014	.0023	.0032
F	10.00	20.0	.0005	.0006	.0009	.0013



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0008	.0018	.0032	.0050
C	.1000	.500	.0009	.0019	.0035	.0053
D	1.000	.500	.0003	.0007	.0012	.0017
E	1.000	20.0	.0003	.0006	.0011	.0016
F	10.00	20.0	.0001	.0002	.0004	.0006

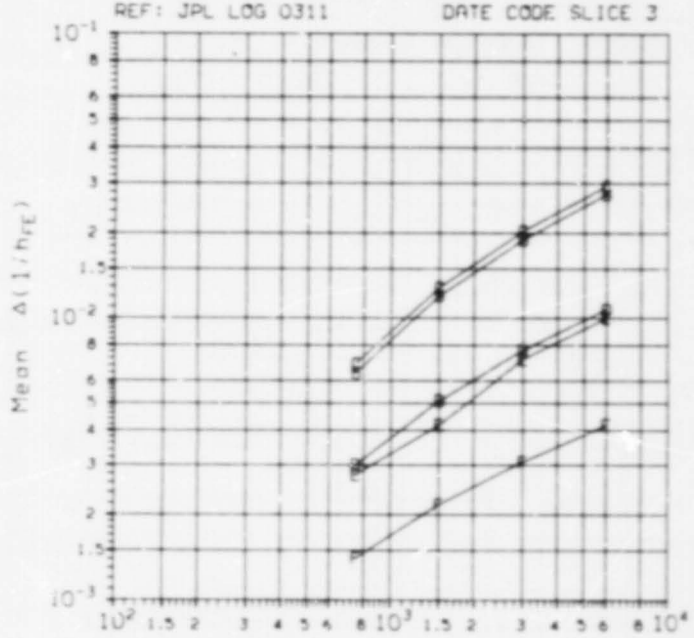
DEVICE TYPE: 2N2920 DUAL NPN TRANSISTOR
MFG: TIx 4 DEVICES TEST DATE 2-9-79
REF: JPL LOG 0307 DATE CODE SLICE 7



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0014	.0029	.0048	.0064
C	.1000	.500	.0015	.0030	.0050	.0068
D	1.000	.500	.0006	.0012	.0018	.0024
E	1.000	20.0	.0006	.0011	.0017	.0023
F	10.00	20.0	.0003	.0006	.0007	.0009

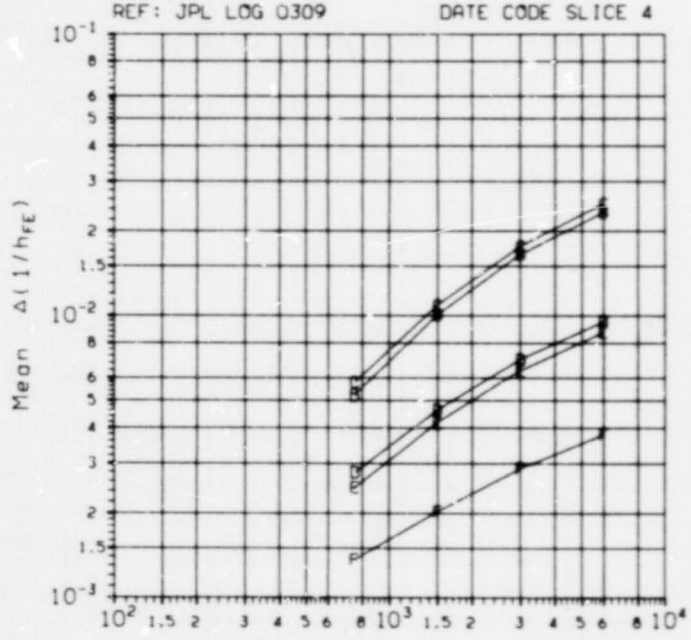
DEVICE TYPE: 2N2920 NPN LOW POWER TRANSISTOR
MFG: TIx 4 DEVICES TEST DATE 2-8-79
REF: JPL LOG 0311 DATE CODE SLICE 3



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0017	.0035	.0059	.0088
C	.1000	.500	.0018	.0037	.0063	.0094
D	1.000	.500	.0008	.0014	.0023	.0033
E	1.000	20.0	.0007	.0014	.0021	.0031
F	10.00	20.0	.0004	.0006	.0009	.0012

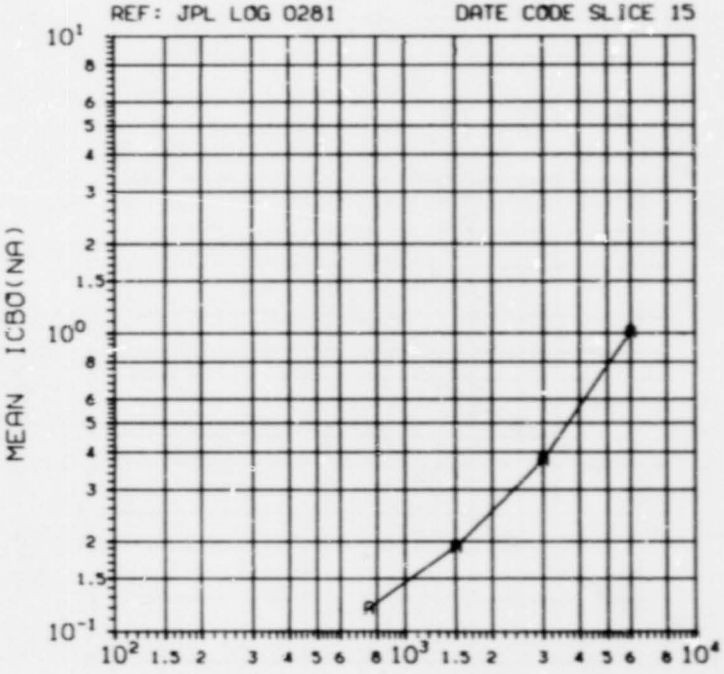
DEVICE TYPE: 2N2920 DUAL NPN TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 2-8-79
REF: JPL LOG 0309 DATE CODE SLICE 4



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.0005	.0008	.0010	.0010
C	.1000	.500	.0004	.0008	.0009	.0011
D	1.000	.500	.0001	.0002	.0003	.0003
E	1.000	20.0	.0002	.0003	.0003	.0004
F	10.00	20.0	.0001	.0001	.0001	.0002

DEVICE TYPE: 2N2920 DUAL NPN TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 1-19-79
REF: JPL LOG 0281 DATE CODE SLICE 15

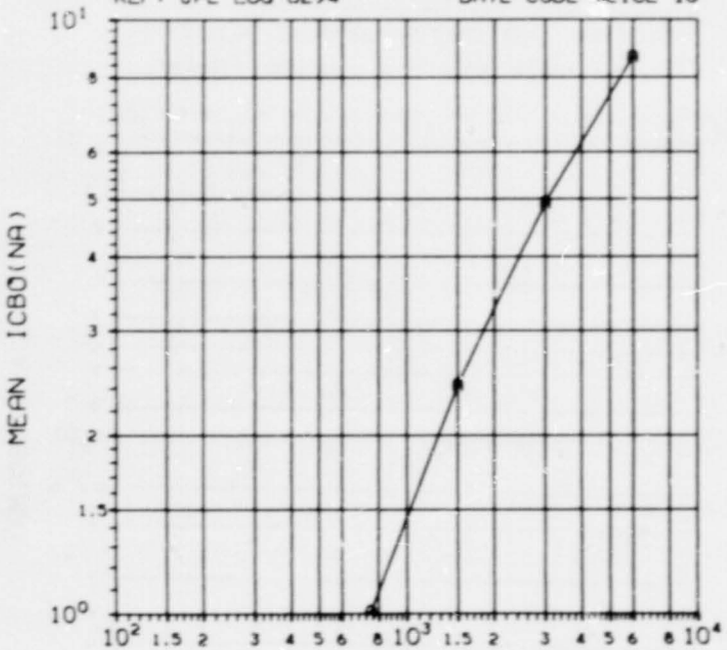


(1)ICBO IN NANOAMPS (VCE=30V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0219	.0325	.1686	1.171

INITIAL MEAN VALUE ICBO(NA) = 8.92×10^{-2}

DEVICE TYPE: 2N2920 DUAL NPN TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 2-20-79
REF: JPL LOG 0294 DATE CODE SLICE 18

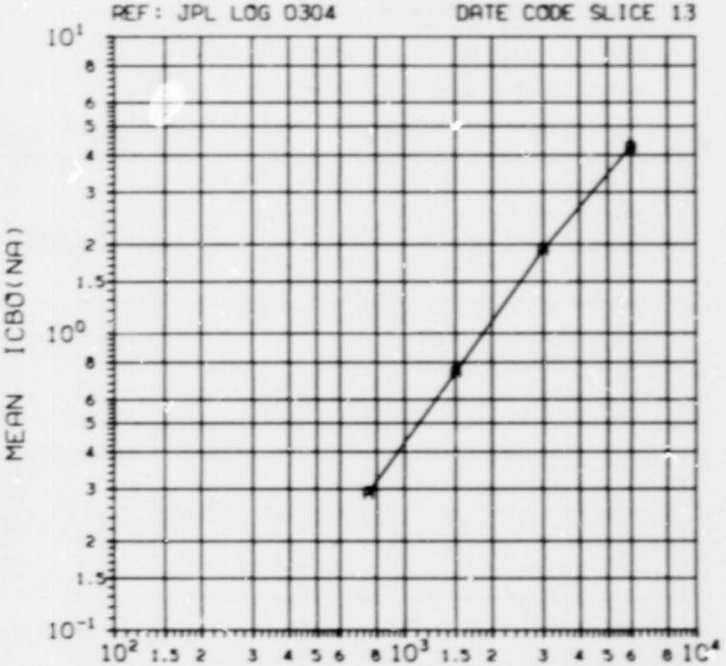


(1)ICBO IN NANOAMPS (VCB=30V): VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.5794	1.246	1.692	2.156

INITIAL MEAN VALUE ICBO(NA) = 1.17×10^{-1}

DEVICE TYPE: 2N2920 DUAL NPN TRANSISTOR
MFG: TIX 3 DEVICES TEST DATE 2-20-79
REF: JPL LOG 0304 DATE CODE SLICE 13

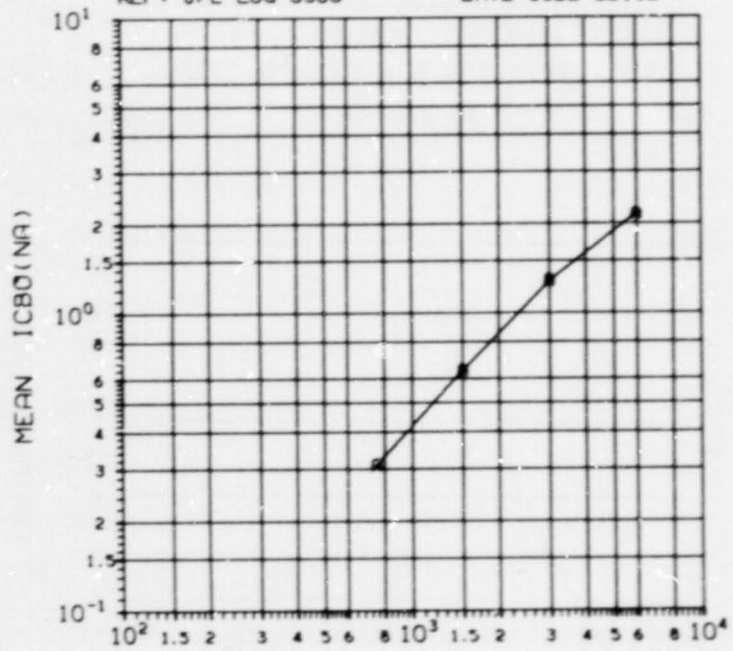


(1)ICBO IN NANOAMPS (VCB=30V): VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0557	.1762	.5346	1.193

INITIAL MEAN VALUE ICBO(NA) = 8.47×10^{-2}

DEVICE TYPE: 2N2920 DUAL NPN TRANSISTOR
MFG: TIX 3 DEVICES TEST DATE 2-20-79
REF: JPL LOG 0308 DATE CODE SLICE 7

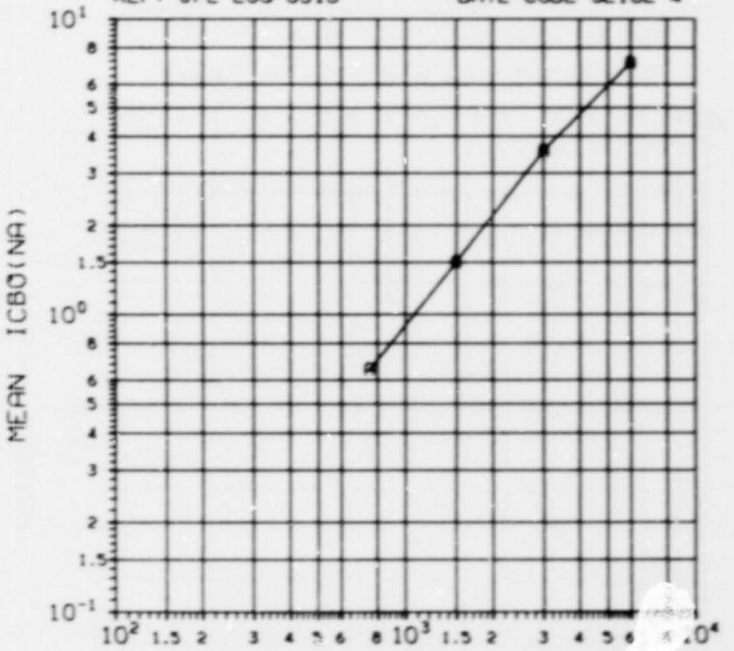


(1)ICBO IN NANOAMPS (VCB=30V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0840	.1852	.4933	.9075

INITIAL MEAN VALUE ICBO(NA) = 1.38×10^{-1}

DEVICE TYPE: 2N2920 DUAL NPN TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 2-20-79
REF: JPL LOG 0310 DATE CODE SLICE 4

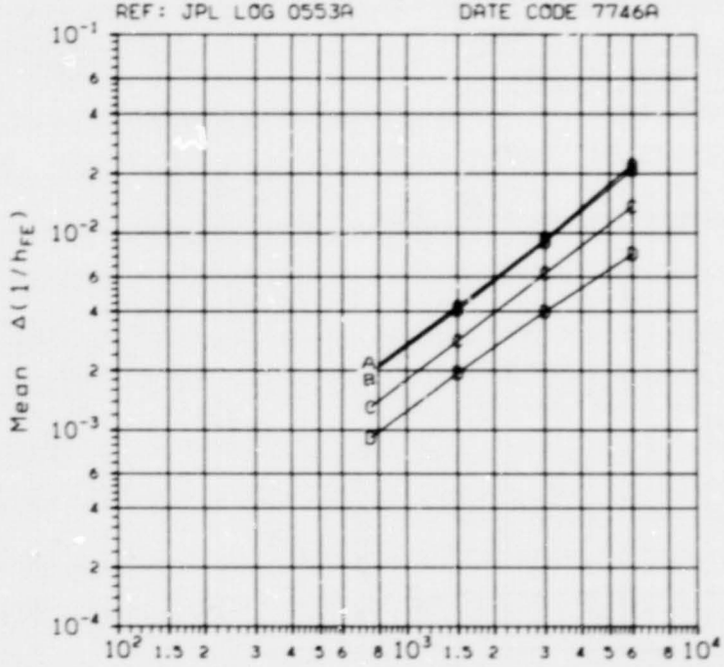


(1)ICBO IN NANOAMPS (VCB=30V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.2789	.6348	1.744	3.801

INITIAL MEAN VALUE ICBO(NA) = 1.45×10^{-1}

DEVICE TYPE: 2N2946 PNP LOW POWER TRANSISTOR
MFG: TIX 9 DEVICES TEST DATE 12-3-79
REF: JPL LOG 0553A DATE CODE 7746A

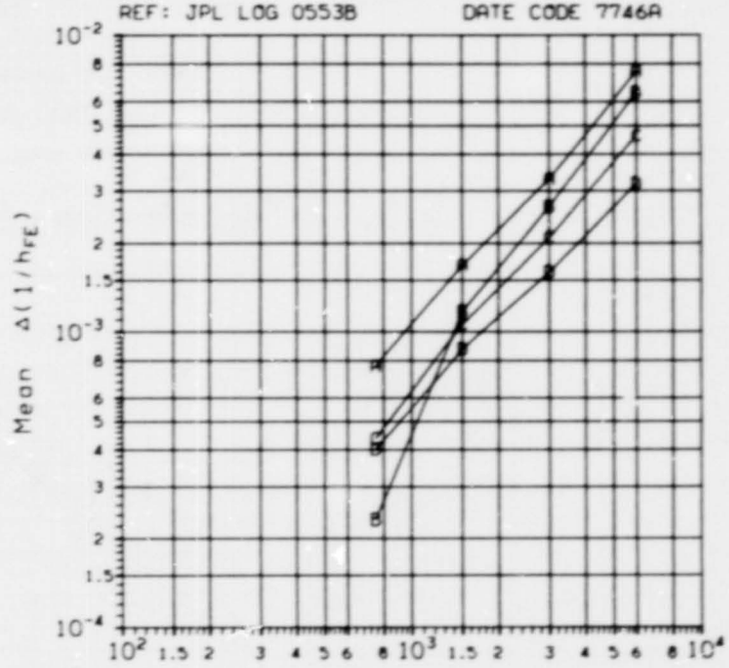


DOSE, Gy(Si) 2.5 MeV electrons

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.1000	20.0	.0005	.0007	.0016	.0035
B	.1000	20.0	.0005	.0006	.0016	.0035
C	1.000	20.0	.0004	.0005	.0011	.0023
D	10.00	20.0	.0003	.0003	.0007	.0013

DEVICE TYPE: 2N2946 PNP LOW POWER TRANSISTOR
MFG: TIX 9 DEVICES TEST DATE 11-29-79
REF: JPL LOG 0553B DATE CODE 7746A

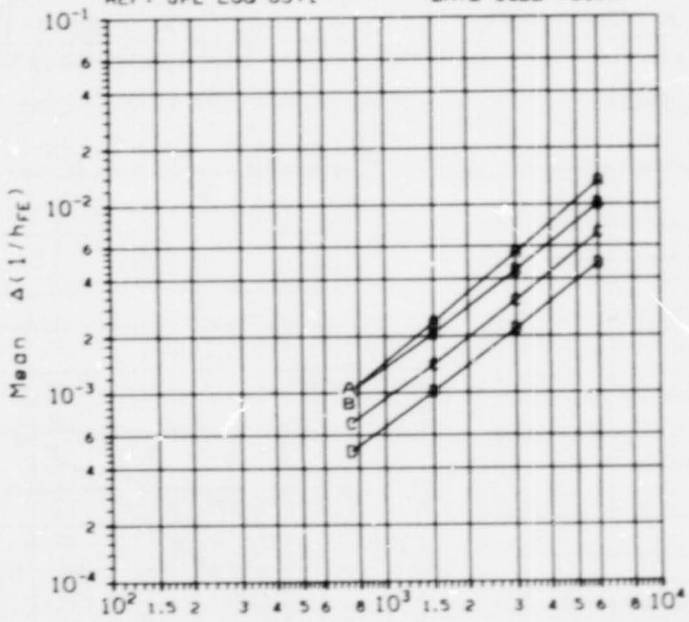


DOSE, Gy(Si) Co^{60} Gammas

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.1000	20.0	.0002	.0005	.0009	.0019
B	.1000	20.0	.0006	.0007	.0009	.0015
C	1.000	20.0	.0002	.0004	.0006	.0010
D	10.00	20.0	.0001	.0003	.0004	.0006

DEVICE TYPE: 2N2946 PNP LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 5-18-79
REF: JPL LOG 0371 DATE CODE 7519A

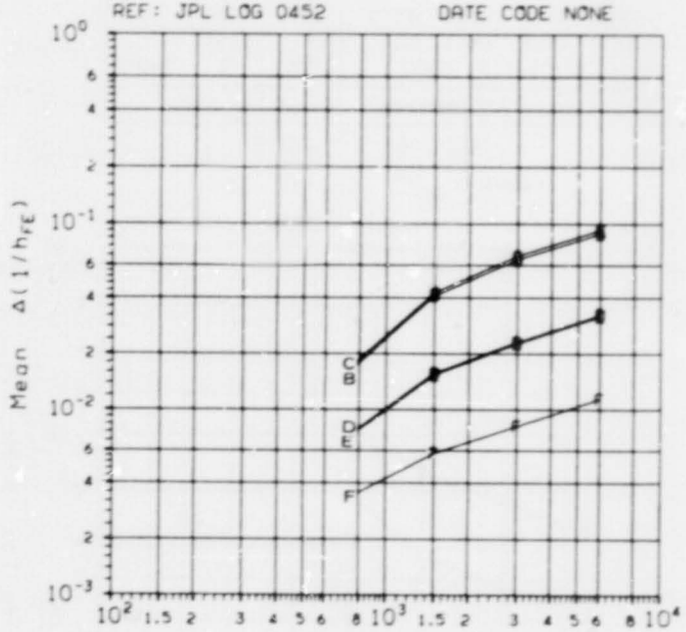


DOSE, Gy(Si) 2.5 MeV electrons

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.1000	20.0	.0001	.0002	.0005	.0016
B	.1000	20.0	.0000	.0001	.0004	.0010
C	1.000	20.0	.0000	.0001	.0003	.0007
D	10.00	20.0	.0000	.0001	.0002	.0005

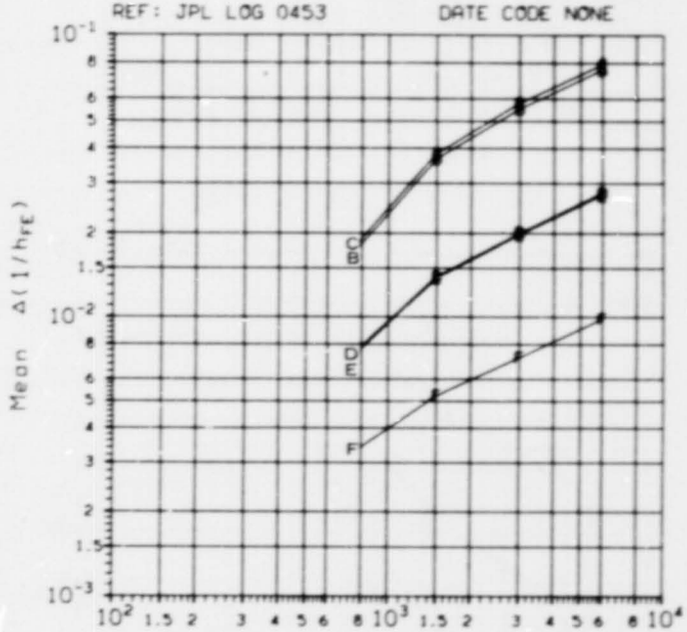
DEVICE TYPE: 2N2975 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 8-16-79
REF: JPL LOG 0452 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.0100	5.00	.0013	.0024	.0017	.0023
C	.0100	.350	.0014	.0026	.0020	.0023
D	.1000	.350	.0006	.0007	.0007	.0008
E	.1000	5.00	.0005	.0007	.0007	.0007
F	1.000	5.00	.0002	.0002	.0003	.0003

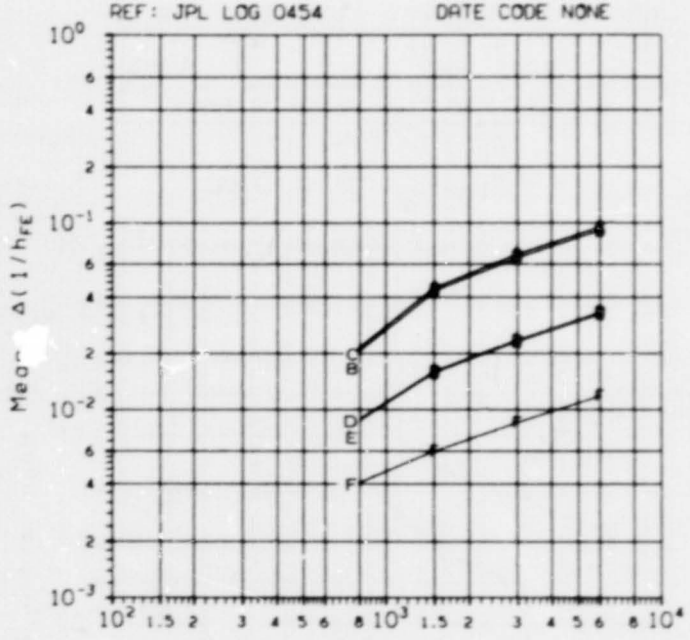
DEVICE TYPE: 2N2975 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 8-16-79
REF: JPL LOG 0453 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.0100	5.00	.0066	.0124	.0145	.0248
C	.0100	.350	.0069	.0129	.0152	.0260
D	.1000	.350	.0025	.0040	.0053	.0094
E	.1000	5.00	.0024	.0040	.0052	.0092
F	1.000	5.00	.0008	.0013	.0020	.0034

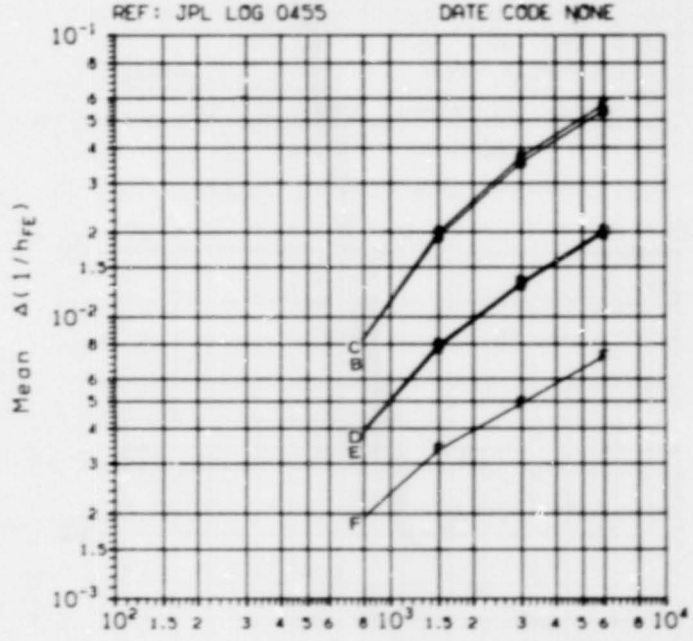
DEVICE TYPE: 2N2975 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 8-16 79
REF: JPL LOG 0454 DATE CODE NONE



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.0100	5.00	.0012	.0043	.0048	.0045
C	.0100	.350	.0013	.0045	.0051	.0046
D	.1000	.350	.0005	.0012	.0015	.0014
E	.1000	5.00	.0005	.0013	.0015	.0013
F	1.000	5.00	.0006	.0003	.0004	.0004

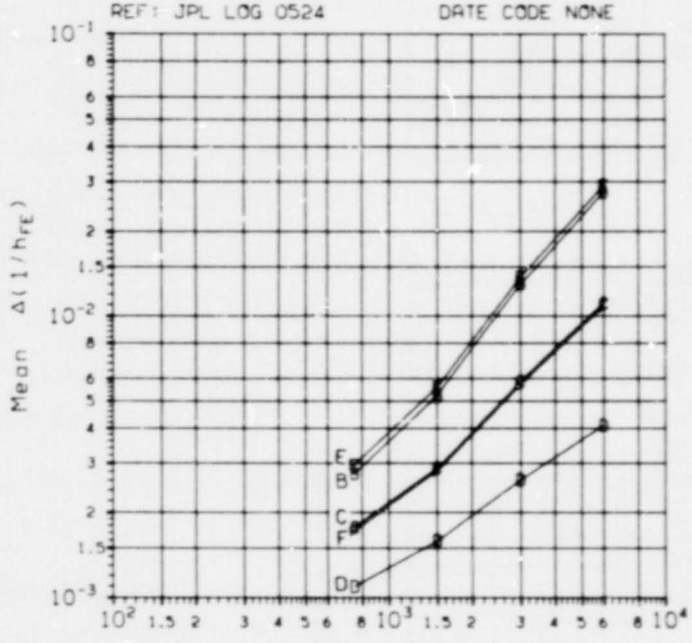
DEVICE TYPE: 2N2975 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 8-16-79
REF: JPL LOG 0455 DATE CODE NONE



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.0100	5.00	.0068	.0182	.0325	.0391
C	.0100	.350	.0067	.0188	.0338	.0409
D	.1000	.350	.0030	.0068	.0109	.0136
E	.1000	5.00	.0029	.0067	.0107	.0134
F	1.000	5.00	.0014	.0023	.0035	.0046

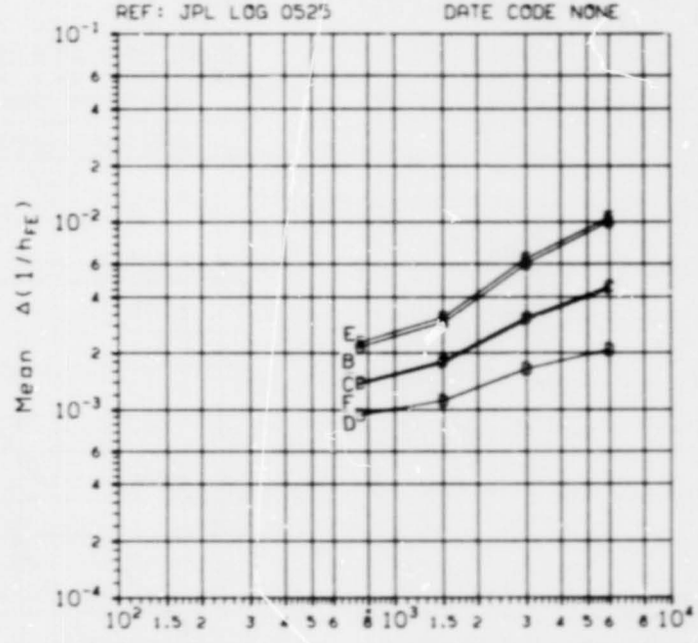
DEVICE TYPE: 2N2975 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 11-7-79
REF: JPL LOG 0524 DATE CODE NONE



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.0100	5.00	.0013	.0027	.0071	.0147
C	.0100	.350	.0008	.0014	.0030	.0057
D	.1000	.350	.0005	.0008	.0013	.0020
E	.1000	5.00	.0014	.0029	.0075	.0154
F	1.000	5.00	.0008	.0013	.0030	.0055

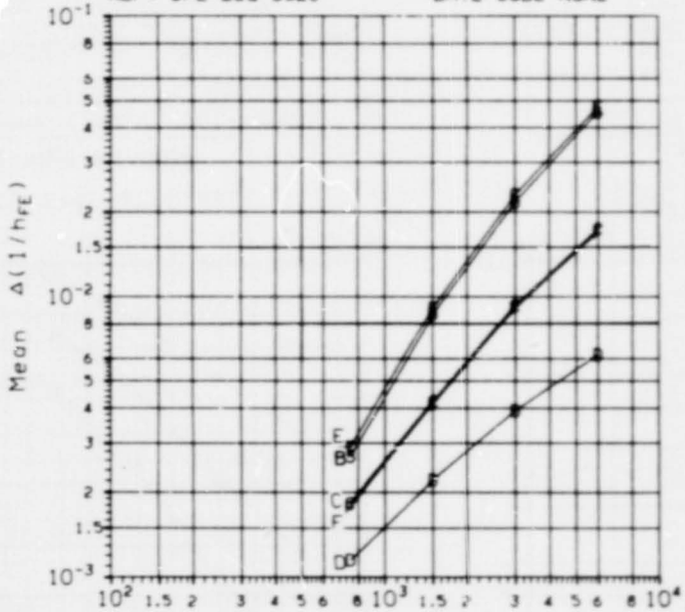
DEVICE TYPE: 2N2975 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 11-7-79
REF: JPL LOG 0525 DATE CODE NONE



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.0100	5.00	.0007	.0017	.0034	.0054
C	.0100	.350	.0004	.0010	.0016	.0022
D	.1000	.350	.0002	.0006	.0009	.0010
E	.1000	5.00	.0007	.0018	.0036	.0057
F	1.000	5.00	.0004	.0010	.0016	.0022

DEVICE TYPE: 2N2975 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 11-7-79
REF: JPL LOG 0526 DATE CODE NONE



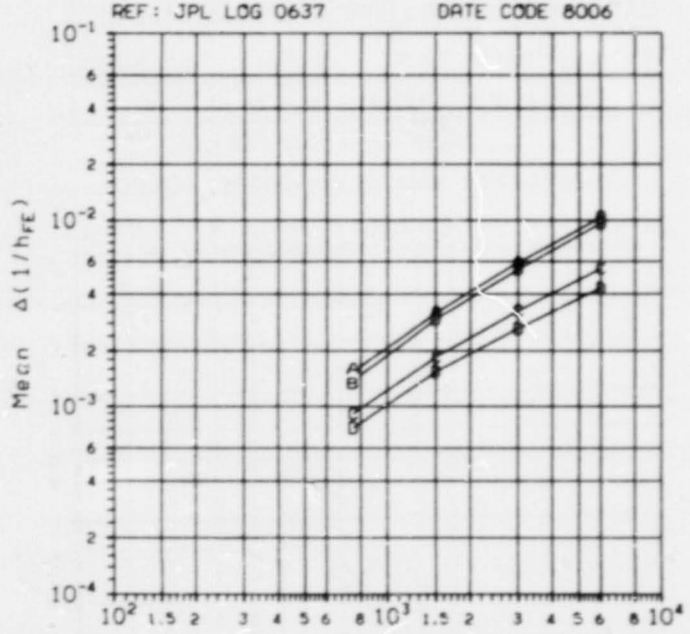
DOSE, Gy(Si) Co^{60} Gammas

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS

CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.0100	5.00	.0016	.0007	.0021	.0034
C	.0100	.350	.0010	.0003	.0008	.0010
D	.1000	.350	.0006	.0001	.0003	.0003
E	.1000	5.00	.0017	.0006	.0024	.0038
F	1.000	5.00	.0010	.0003	.0008	.0009

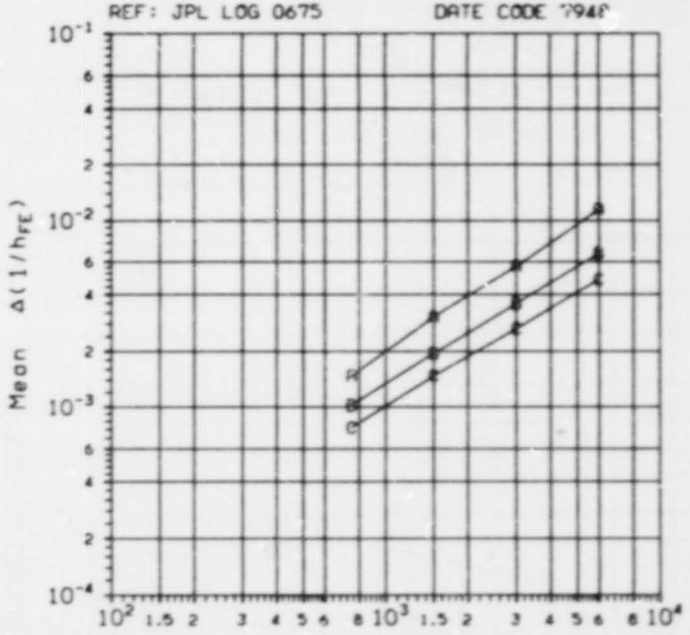
DEVICE TYPE: 2N3251 PNP LOW POWER TRANSISTOR
MFG: MOT 6 DEVICES TEST DATE 3-11-80
REF: JPL LOG 0637 DATE CODE 8006



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.000	20.0	.0002	.0002	.0005	.0007
B	1.000	20.0	.0001	.0003	.0005	.0007
C	5.000	20.0	.0001	.0001	.0002	.0003
D	10.00	20.0	.0001	.0001	.0002	.0002

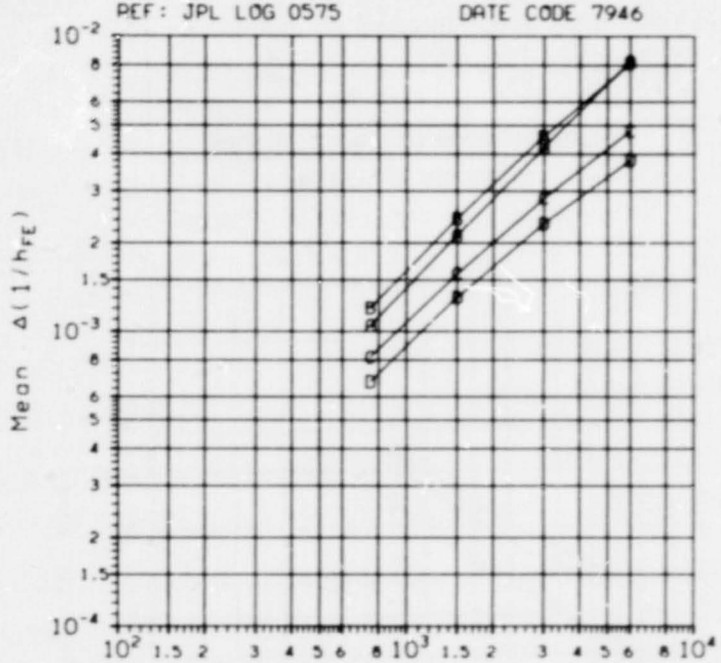
DEVICE TYPE: 2N3251 PNP LOW POWER TRANSISTOR
MFG: MOT 3 DEVICES TEST DATE 8-27-80
REF: JPL LOG 0675 DATE CODE 7948



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.1000	15.0	.0006	.0010	.0017	.0025
B	.4000	****	.0004	.0006	.0008	.0013
C	1.000	****	.0002	.0003	.0005	.0007

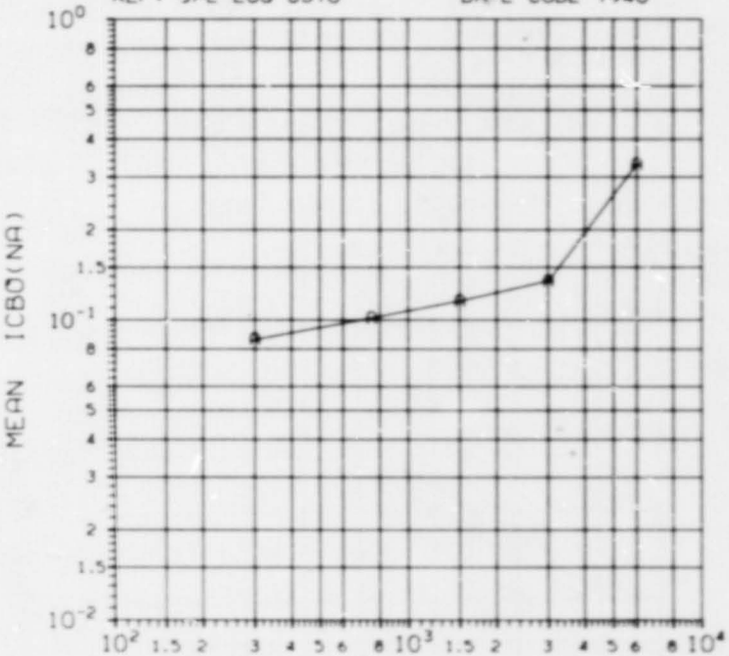
DEVICE TYPE: 2N3251 PNP LOW POWER TRANSISTOR
MFG: MOT 6 DEVICES TEST DATE 1-2-80
REF: JPL LOG 0575 DATE CODE 7946



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.000	20.0	.0001	.0002	.0003	.0012
B	1.000	20.0	.0001	.0002	.0003	.0007
C	5.000	20.0	.0001	.0001	.0002	.0003
D	10.00	20.0	.0001	.0001	.0002	.0003

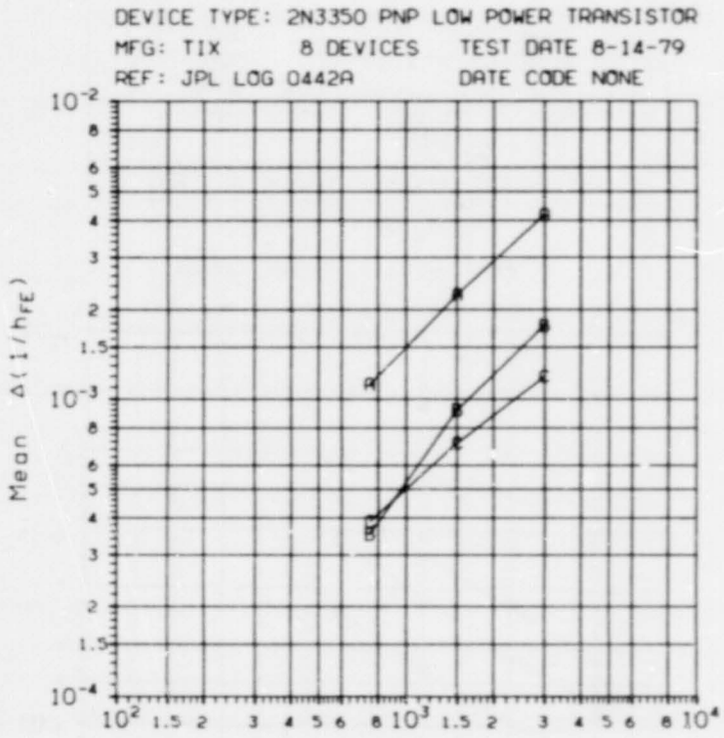
DEVICE TYPE: 2N3251 PNP LOW POWER TRANSISTOR
MFG: MOT 5 DEVICES TEST DATE 1-3-80
REF: JPL LOG 0576 DATE CODE 7946



(1) ICBO IN NA; VCE=15V VS DOSE

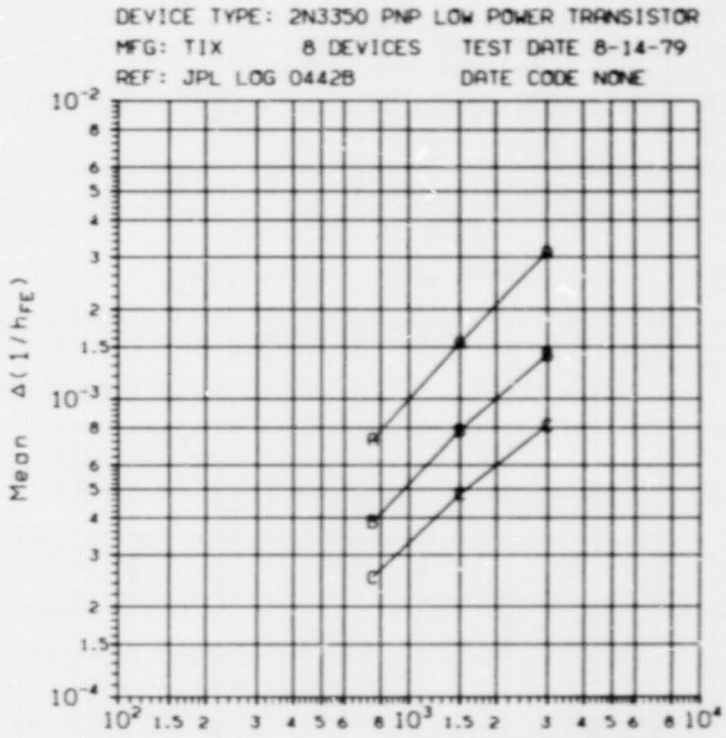
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	DOSE, kiloGy(Si) .30	.75	1.50	3.00	6.00
A	.0106	.0090	.0096	.0035	.0272

INITIAL MEAN VALUE ICBO(NA) = 8.66×10^{-2}



Δ(1/h_{FE}) VS DOSE

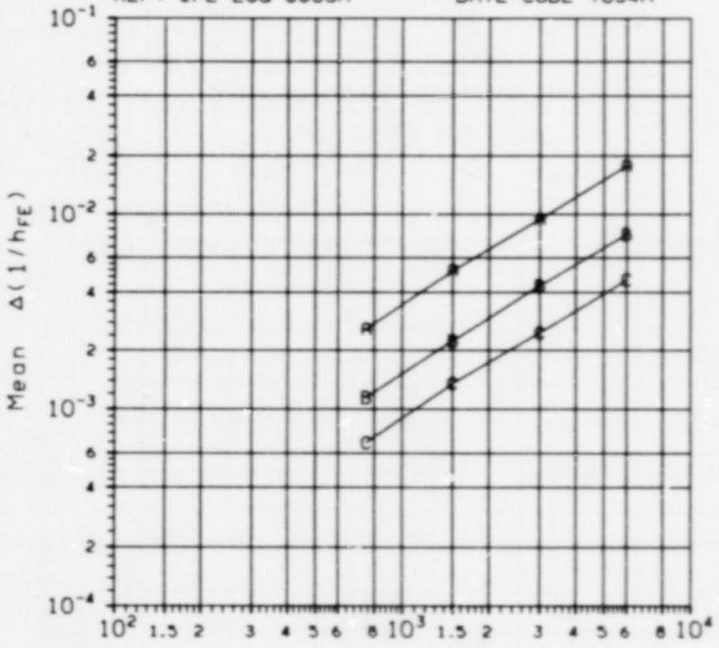
TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
A	.0100	.500	.0001	.0004	.0008
B	.1000	.500	.0001	.0002	.0003
C	1.000	.500	.0001	.0001	.0002



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
A	.0100	.500	.0002	.0003	.0006
B	.1000	.500	.0001	.0001	.0002
C	1.000	.500	.0001	.0001	.0001

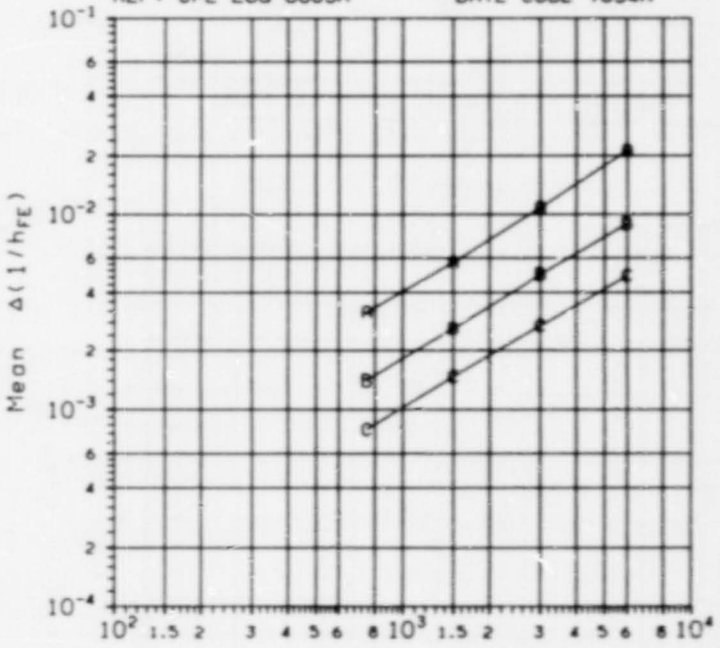
DEVICE TYPE: 2N3350 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 4-9-80
REF: JPL LOG 0603A DATE CODE 7834A



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	.500	.0007	.0016	.0024	.0043
B	.1000	.500	.0003	.0005	.0008	.0012
C	1.000	.500	.0001	.0002	.0003	.0004

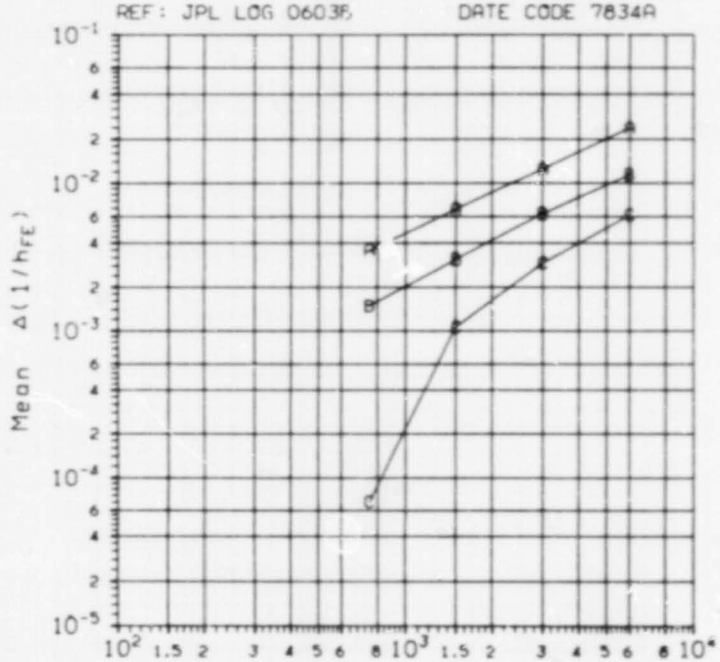
DEVICE TYPE: 2N3350 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 4-9-80
REF: JPL LOG 0603A DATE CODE 7834A



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	.500	.0016	.0027	.0047	.0078
B	.1000	.500	.0006	.0009	.0017	.0026
C	1.000	.500	.0002	.0004	.0006	.0010

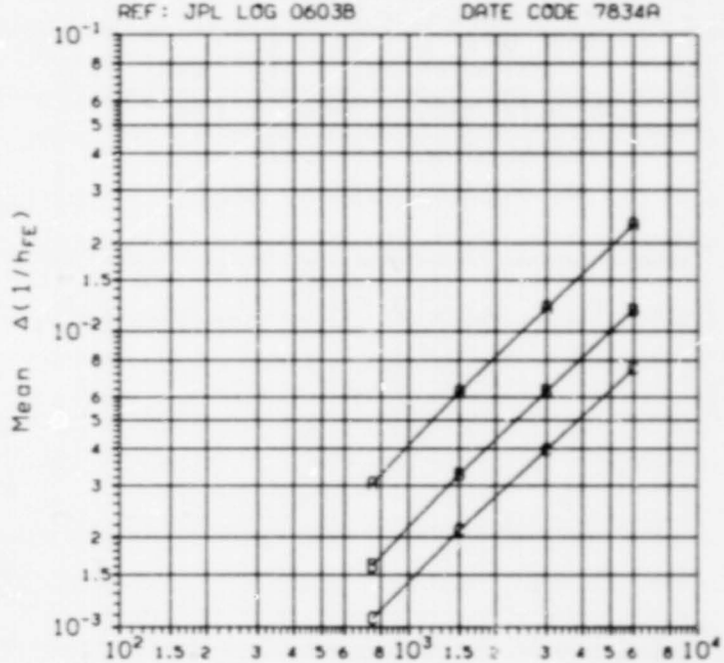
DEVICE TYPE: 2N3350 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 4-15-80
REF: JPL LOG 06038 DATE CODE 7834A



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	.500	.0007	.0010	.0013	.0022
B	.1000	.500	.0003	.0005	.0006	.0008
C	1.000	.500	.0012	.0012	.0013	.0014

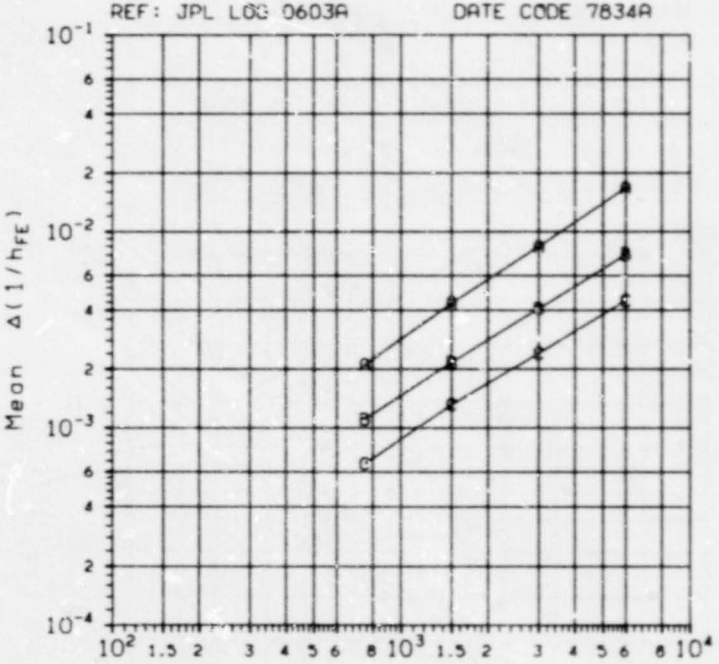
DEVICE TYPE: 2N3350 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 4-15-80
REF: JPL LOG 06038 DATE CODE 7834A



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	.500	.0006	.0004	.0007	.0010
B	.1000	.500	.0001	.0002	.0003	.0004
C	1.000	.500	.0001	.0001	.0001	.0006

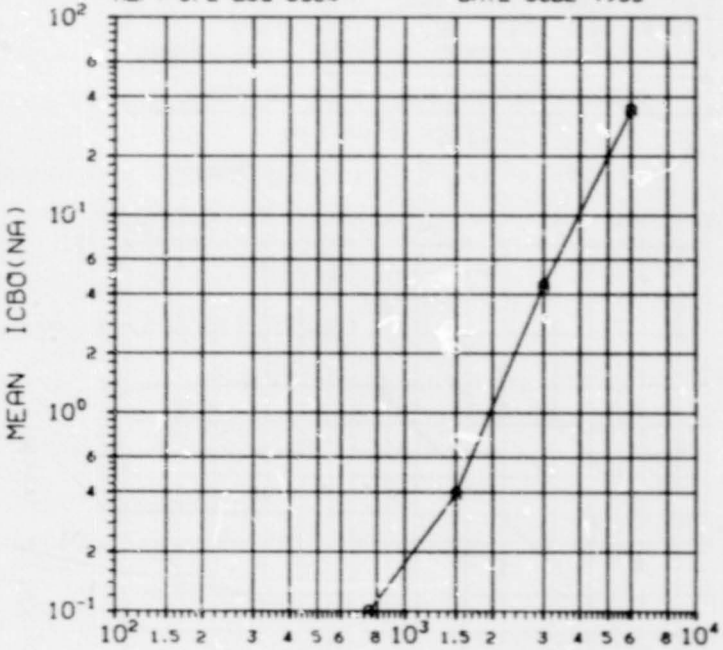
DEVICE TYPE: 2N3350 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 4-9-80
REF: JPL LOG 0603A DATE CODE 7834A



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	.500	.0002	.0004	.0008	.0015
B	.1000	.500	.0001	.0002	.0005	.0007
C	1.000	.500	.0001	.0001	.0003	.0004

DEVICE TYPE: 2N3350 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 11-7-79
REF: JPL LOG 0534 DATE CODE 7935

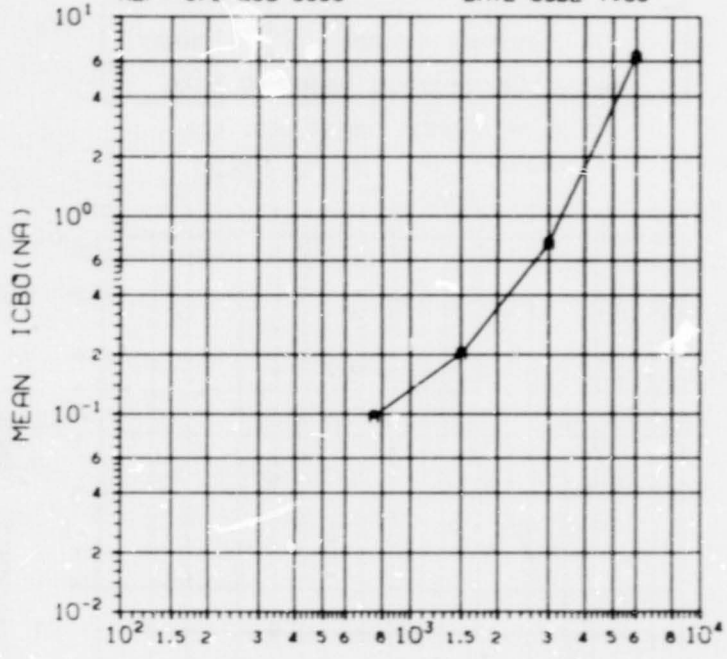


(1) ICBO IN NA; VCB=20V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0682	.4081	5.695	46.12

INITIAL MEAN VALUE ICBO(NA) = 7.62×10^{-2}

DEVICE TYPE: 2N3350 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 11-7-79
REF: JPL LOG 0535 DATE CODE 7935

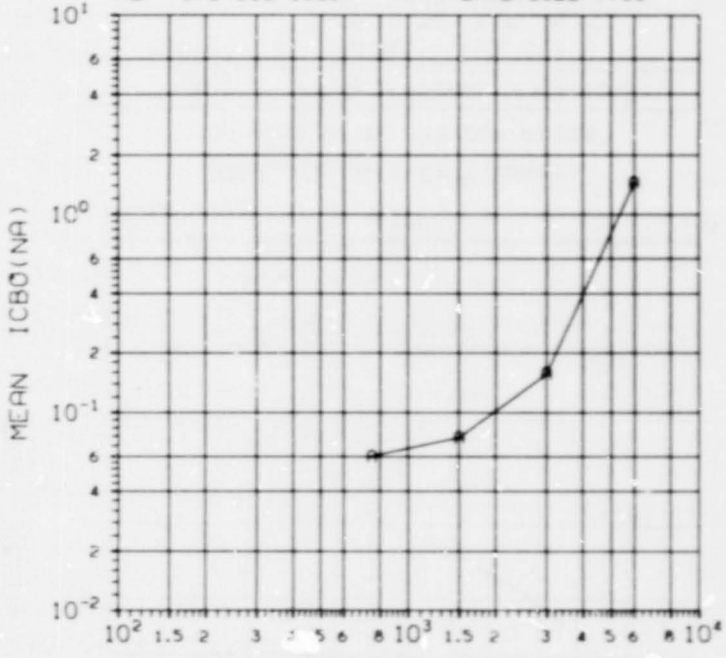


(1) ICBO IN NA; VCB=20V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.1670	.3631	.2105	1.432

INITIAL MEAN VALUE ICBO(NA) = 2.25×10^{-1}

DEVICE TYPE: 2N3350 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 11-7-79
REF: JPL LOG 0536 DATE CODE 7935

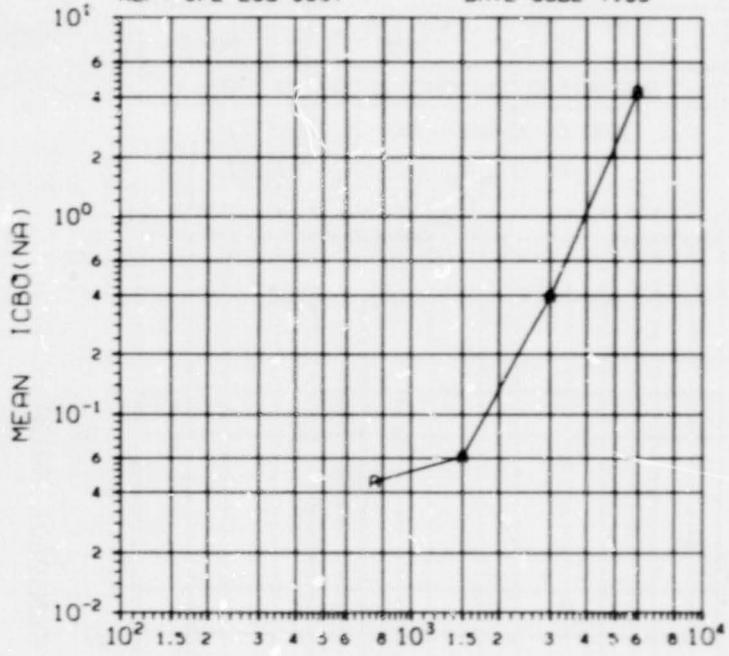


(1) ICBO IN NA; VCB=20V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloCy(Si)			
	.75	1.50	3.00	6.00
A	.0654	.0679	.1383	2.052

INITIAL MEAN VALUE ICBO(NA) = 8.16×10^{-2}

DEVICE TYPE: 2N3350 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 11-7-79
REF: JPL LOG 0537 DATE CODE 7935

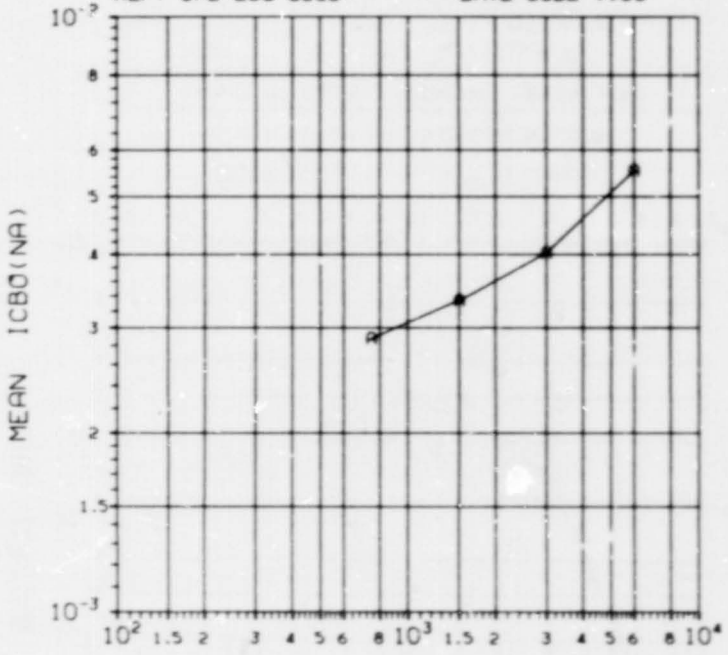


(1) ICBO IN NA; VCB=20V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0091	.0080	.1116	1.011

INITIAL MEAN VALUE ICBO(NA) = 4.84×10^{-2}

DEVICE TYPE: 2N3350 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 11-7-79
REF: JPL LOG 0538 DATE CODE 7935

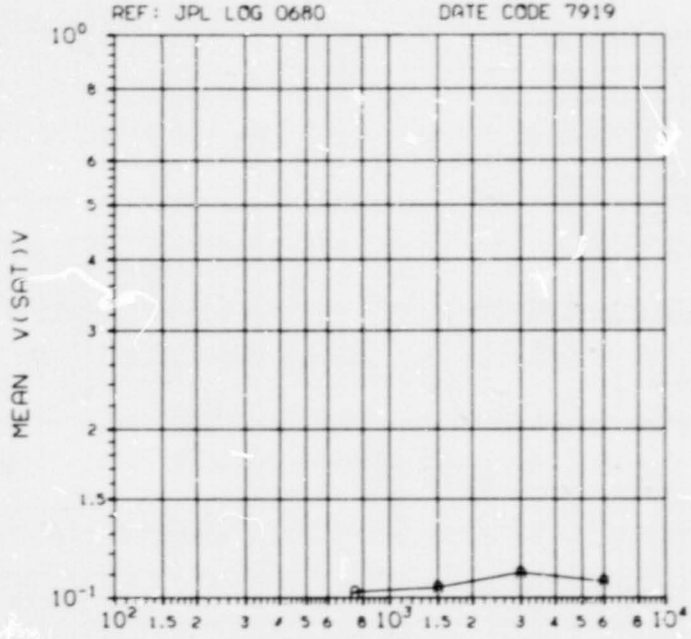


(1) ICBO IN NA; VCB=20V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0005	.0007	.0008	.0019

INITIAL MEAN VALUE ICBO(NA) = 3.01×10^{-3}

DEVICE TYPE: 2N3375 NPN POWER TRANSISTOR
MFG: RCA 5 DEVICES TEST DATE 8-11-80
REF: JPL LOG 0680 DATE CODE 7919



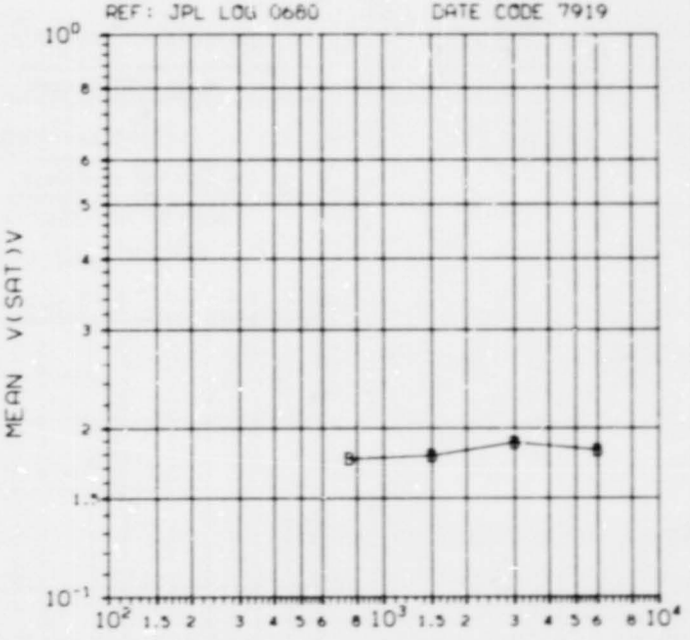
DOSE, Gy(Si) Co^{60} Gammas

(1) VSAT-1 IN VOLTS; IC=100MA, IB=10 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0095	.0097	.0103	.0100

INITIAL MEAN VALUE V(SAT)V = 9.98×10^{-2}

DEVICE TYPE: 2N3375 NPN POWER TRANSISTOR
MFG: RCA 5 DEVICES TEST DATE 8-11-80
REF: JPL LOG 0680 DATE CODE 7919



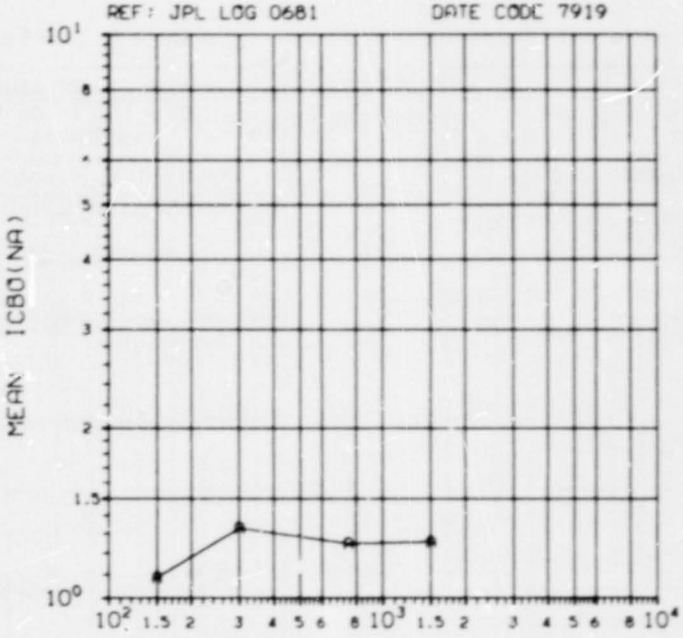
DOSE, Gy(Si) Co^{60} Gammas

(2) VSAT-2 IN VOLTS; IC=250MA, IB=25 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	.0119	.0125	.0142	.0130

INITIAL MEAN VALUE V(SAT)V = 1.73×10^{-1}

DEVICE TYPE: 2N3375 NPN POWER TRANSISTOR
MFG: RCA 5 DEVICES TEST DATE 8-11-80
REF: JPL LOG 0681 DATE CODE 7919

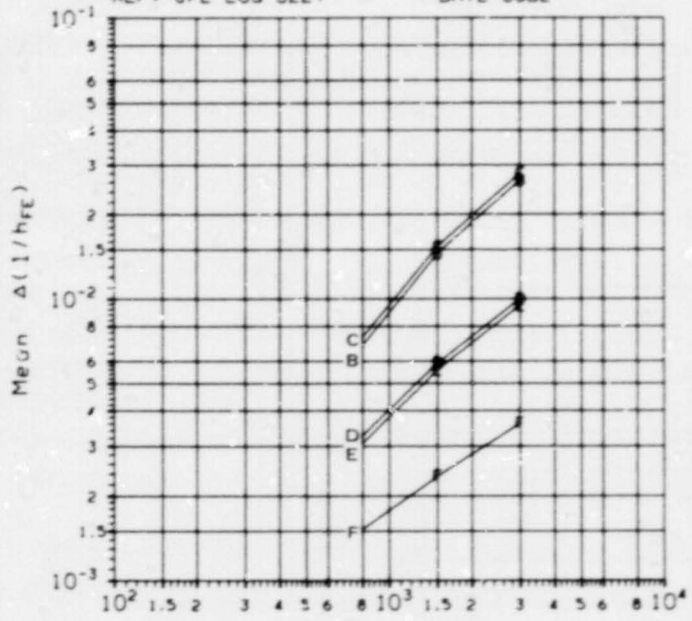


(1) ICEO IN NA; VCE=12V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.15	.30	.75	1.50
A	.3015	.1447	.1006	.0702

INITIAL MEAN VALUE ICBO(NA) = 1.03×10^0

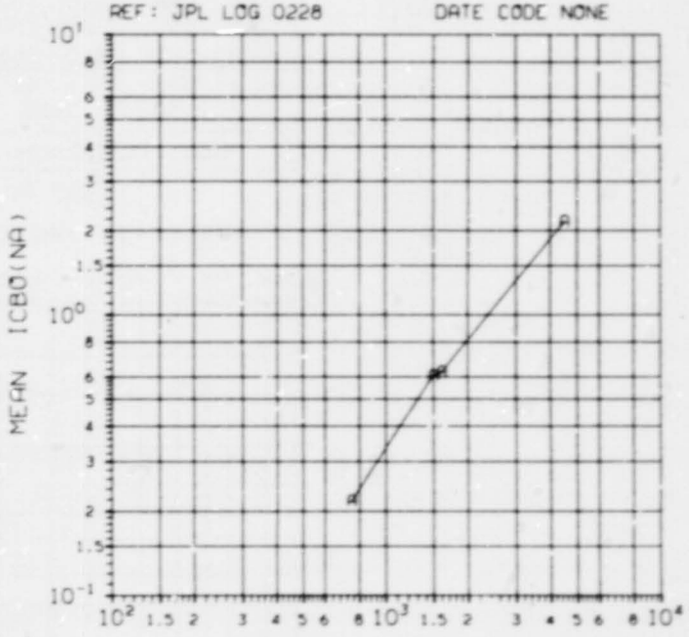
DEVICE TYPE: 2N3391 NPN LOW POWER TRANSISTOR
MFG: TIX 5 DEVICES TEST DATE 11-1-78
REF: JPL LOG 0227 DATE CODE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
B	.1000	20.0	.0045	.0073	.0099
C	.1000	.500	.0048	.0077	.0104
D	1.000	.500	.0019	.0028	.0036
E	1.000	20.0	.0018	.0027	.0034
F	10.00	20.0	.0008	.0012	.0015

DEVICE TYPE: 2N3391 NPN LOW POWER TRANSISTOR
MFG: TIX 5 DEVICES TEST DATE 11-3-78
REF: JPL LOG 0228 DATE CODE NONE

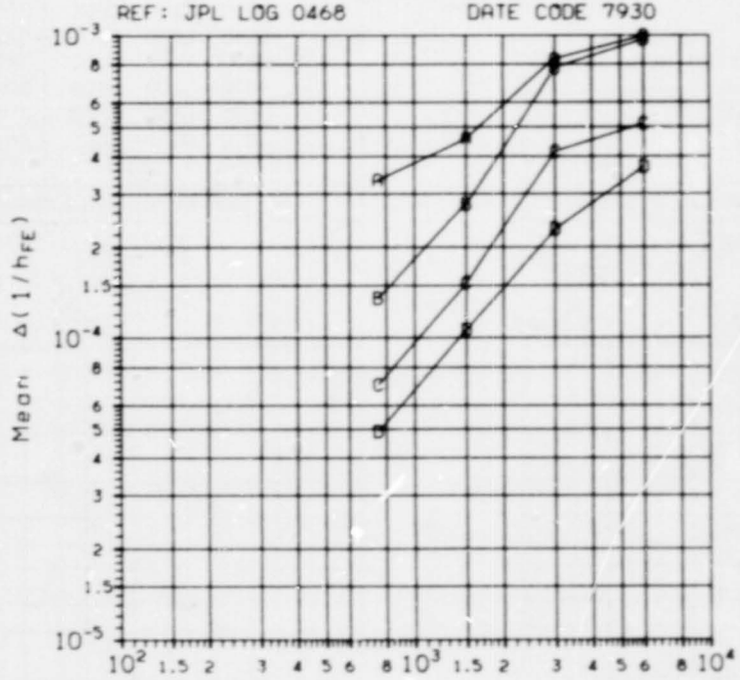


(1) ICBO, VCE=30V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	1.61	4.50
A	.0455	.1842	.1918	.6078

INITIAL MEAN VALUE ICBO(NA) = 7.20×10^{-2}

DEVICE TYPE: 2N3467 PNP POWER TRANSISTOR
MFG: MOT 6 DEVICES TEST DATE 9-10-79
REF: JPL LOG 0468 DATE CODE 7930

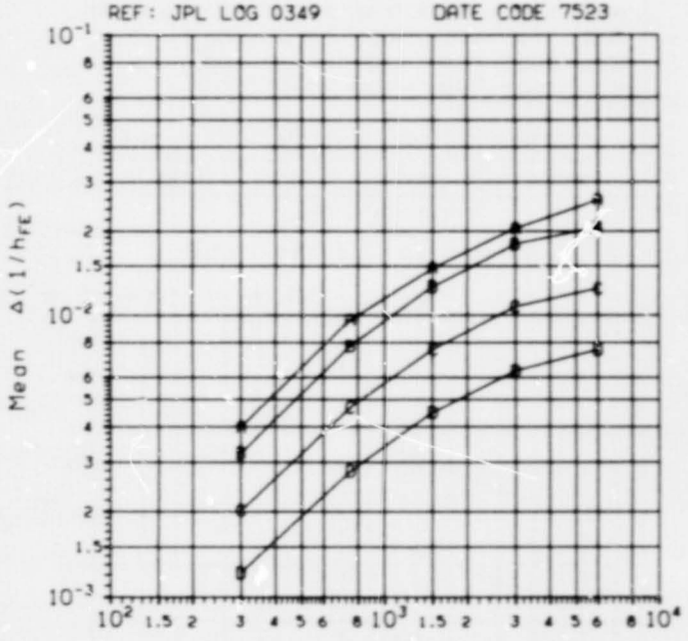


DOSE, Gy(Si) 2.5 MeV electrons

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.000	20.0	.0002	.0001	.0003	.0002
B	1.000	20.0	.0001	.0003	.0002	.0001
C	10.00	20.0	.0001	.0002	.0001	.0001
D	10.00	20.0	.0001	.0001	.0001	.0001

DEVICE TYPE: 2N3499 NPN POWER TRANSISTOR
MFG: MOT 4 DEVICES TEST DATE 4-18-79
REF: JPL LOG 0349 DATE CODE 7523

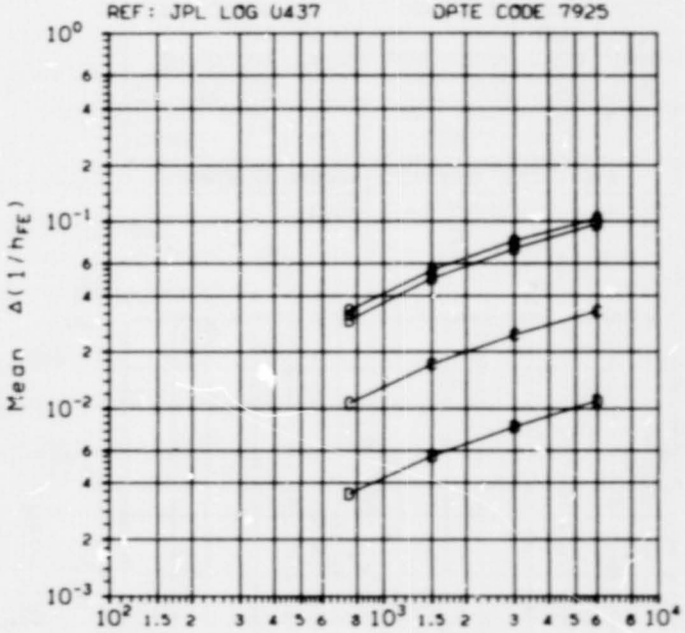


DOSE, Gy(Si) 2.5 MeV electrons

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .30	.75	1.50	3.00
0	5.000	20.0	.0030	.0035	.0059	.0093
B	5.000	20.0	.0020	.0034	.0051	.0068
C	1.000	20.0	.0011	.0018	.0027	.0036
D	20.00	20.0	.0006	.0010	.0014	.0020

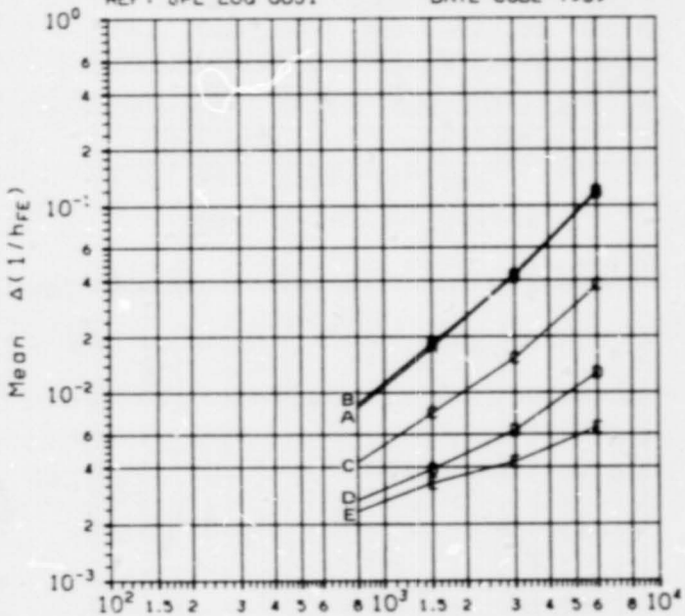
DEVICE TYPE: 2N3501 NPN POWER TRANSISTOR
MFG: MOT 6 DEVICES TEST DATE 7-20-79
REF: JPL LOG U437 DATE CODE 7925



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	.00	6.00
0	.1000	20.0	.0022	.0030	.0037	.0031
B	.1000	20.0	.0019	.0030	.0039	.0035
C	1.000	20.0	.0006	.0008	.0011	.0011
D	10.00	20.0	.0001	.0002	.0004	.0004

DEVICE TYPE: 2N3506 N-P-N POWER TRANSISTOR
MFG: GEC 3 DEVICES TEST DATE 3-4-80
REF: JPL LOG 0631 DATE CODE 7939

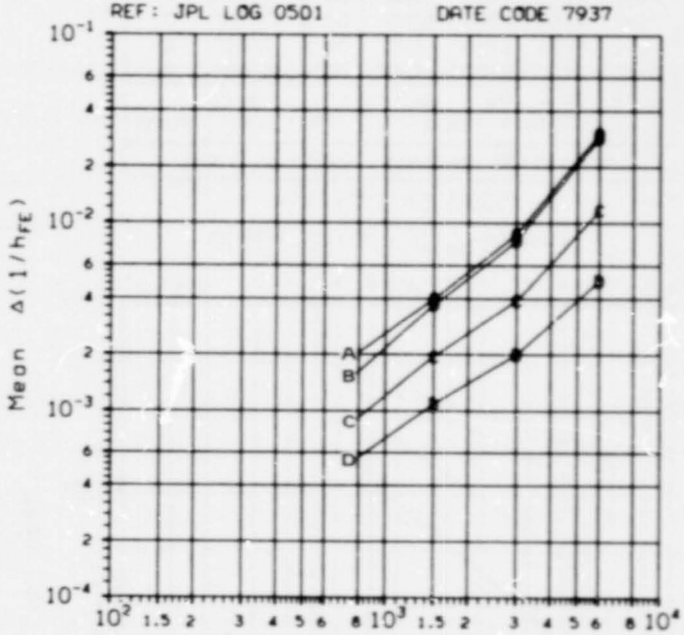


DOSE, Gy(Si) Co^{60} Gammas

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (A)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0010	5.00	.0013	.0013	.0041	.0191
B	.0010	5.00	.0017	.0013	.0047	.0187
C	.0100	5.00	.0005	.0003	.0014	.0052
D	.1000	5.00	.0001	.0001	.0004	.0012
E	1.000	5.00	.0001	.0002	.0000	.0002

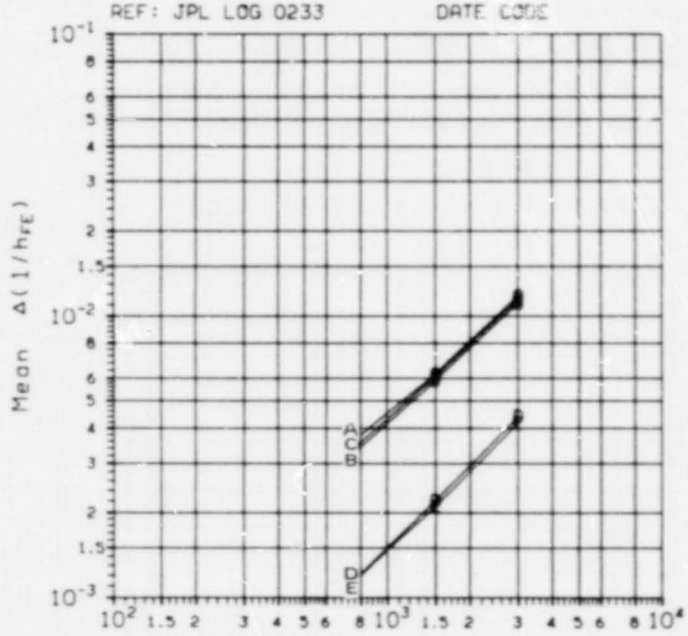
DEVICE TYPE: 2N3637 PNP POWER TRANSISTOR
MFG: MOT 6 DEVICES TEST DATE 10-16-79
REF: JPL LOG 0501 DATE CODE 7937



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.1000	20.0	.0001	.0001	.0005	.0029
B	.1000	20.0	.0001	.0003	.0007	.0027
C	1.000	20.0	.0001	.0001	.0003	.0010
D	10.00	20.0	.0001	.0001	.0001	.0003

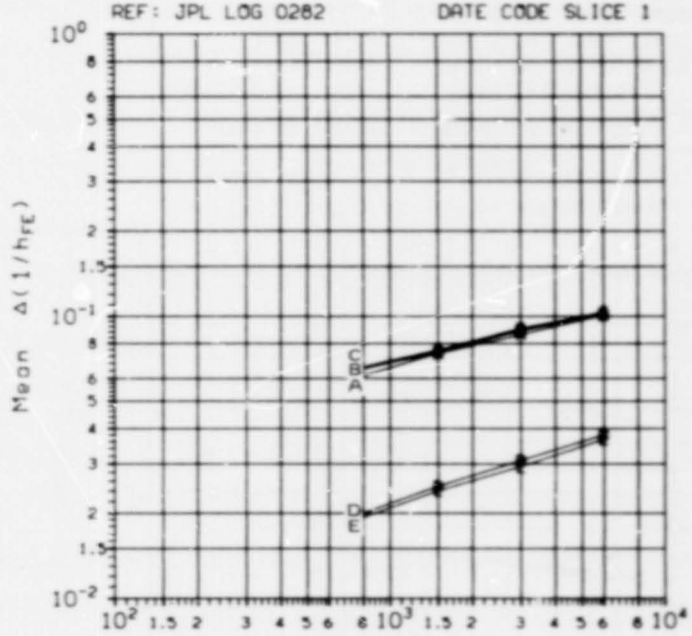
DEVICE TYPE: 2N3700 NPN LOW POWER TRANSISTOR
MFG: TIX 5 DEVICES TEST DATE 10-31-78
REF: JPL LOG 0233 DATE CODE



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
A	1.000	20.0	.0005	.0009	.0014
B	1.000	20.0	.0003	.0007	.0011
C	1.000	.500	.0003	.0007	.0012
D	10.00	.500	.0002	.0002	.0003
E	10.00	20.0	.0001	.0002	.0003

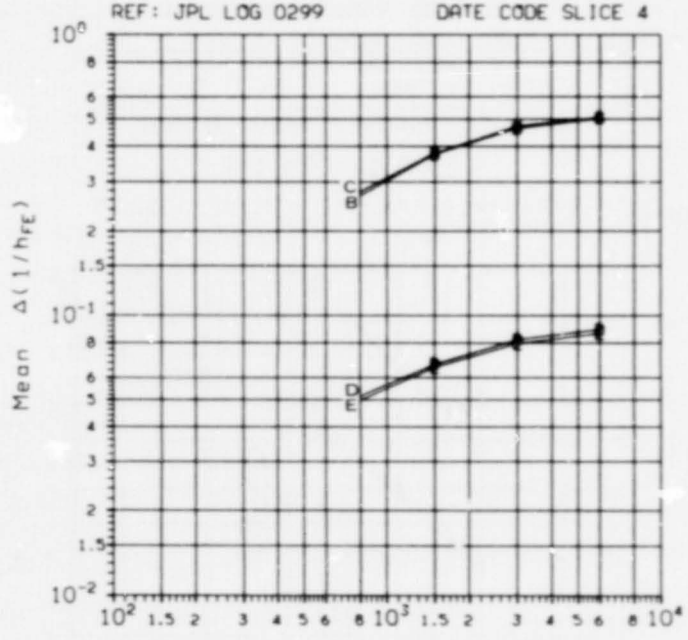
DEVICE TYPE: 2N3700 NPN LOW POWER TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 1-16-79
REF: JPL LOG 0282 DATE CODE SLICE 1



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.000	20.0	.0060	.0067	.0078	.0070
B	1.000	20.0	.0063	.0075	.0083	.0065
C	1.000	.500	.0064	.0076	.0084	.0066
D	10.00	.500	.0011	.0014	.0020	.0032
E	10.00	20.0	.0011	.0014	.0021	.0032

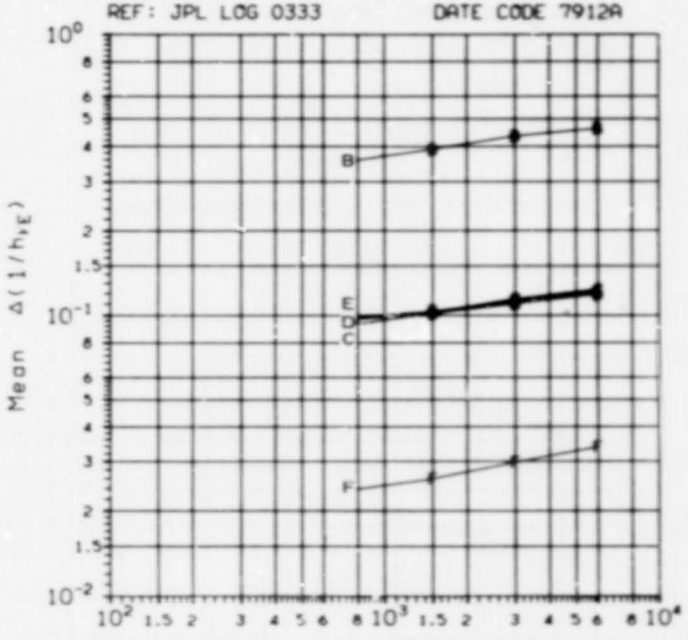
DEVICE TYPE: 2N3700 NPN LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 2-16-79
REF: JPL LOG 0299 DATE CODE SLICE 4



Δ(1/h_{FE}) VS DOSE

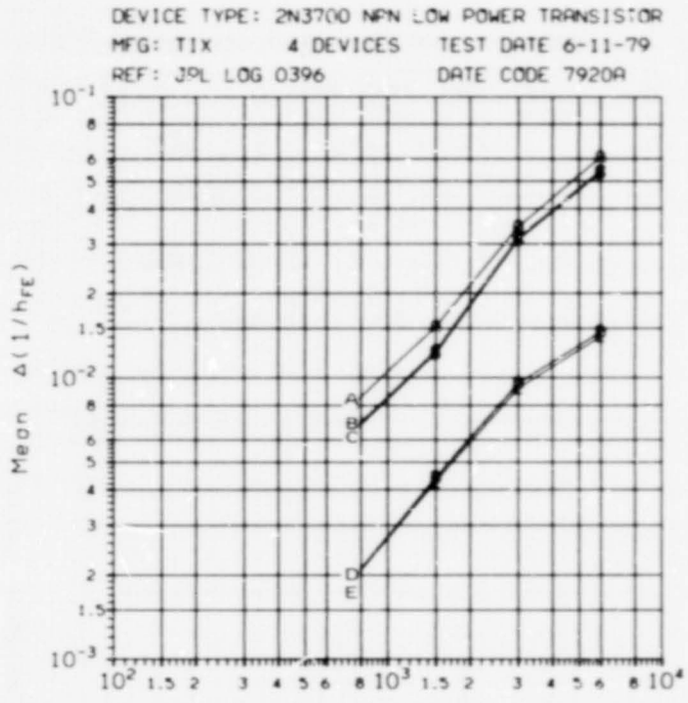
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	1.000	20.0	.0928	.1682	.2239	.2409
C	1.000	.500	.0840	.1693	.2276	.2419
D	10.00	.500	.0147	.0244	.0311	.0324
E	10.00	20.0	.0142	.0242	.0306	.0316

DEVICE TYPE: 2N3700 NPN LOW POWER TRANSISTOR
MFG: TIX 5 DEVICES TEST DATE 3-23-79
REF: JPL LOG 0333 DATE CODE 7912A



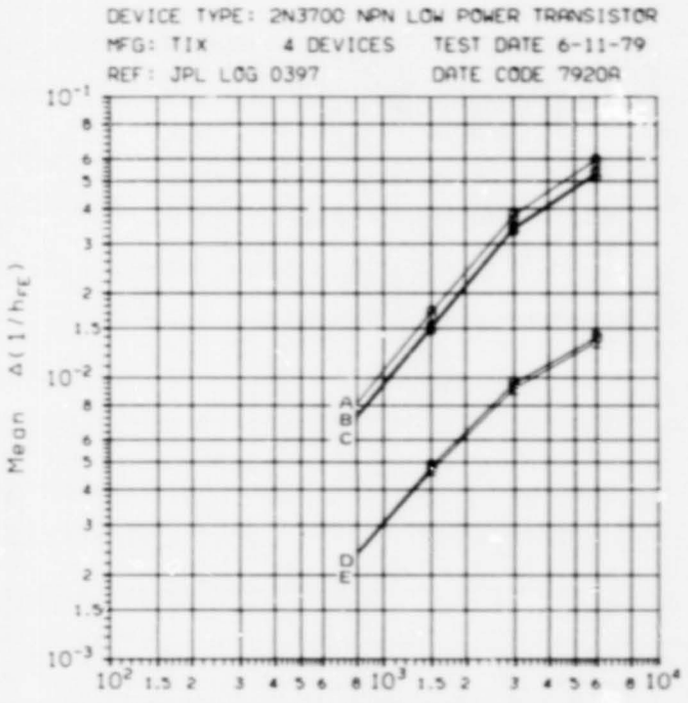
Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.1000	20.0	.1313	.1723	.1989	.1952
C	1.000	20.0	.0326	.0407	.0451	.0452
D	1.000	20.0	.0296	.0382	.0413	.0399
E	1.000	.500	.0304	.0391	.0420	.0405
F	10.00	.500	.0054	.0067	.0068	.0060



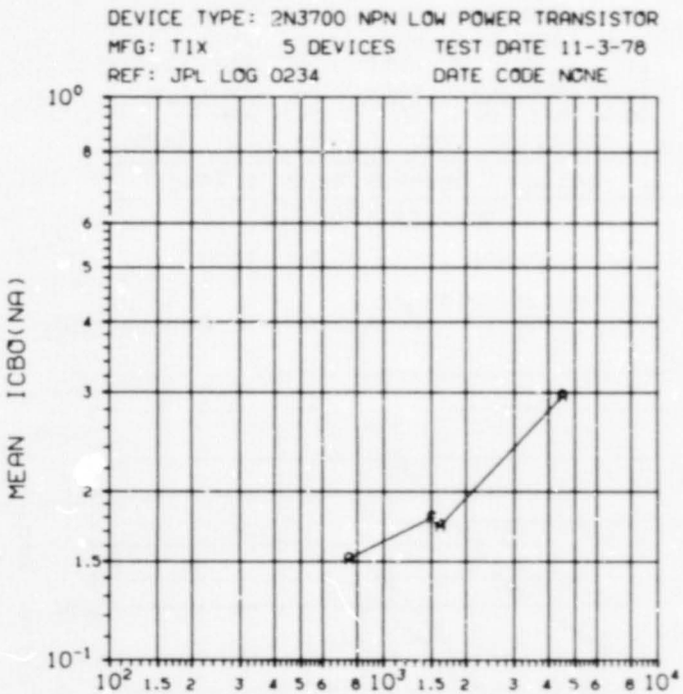
Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.000	20.0	.0004	.0009	.0026	.0019
B	1.000	20.0	.0004	.0010	.0019	.0017
C	1.000	.500	.0004	.0010	.0019	.0017
D	10.00	20.0	.0002	.0003	.0004	.0004
E	10.00	.500	.0002	.0003	.0004	.0004



Δ(1/h_{FE}) VS DOSE

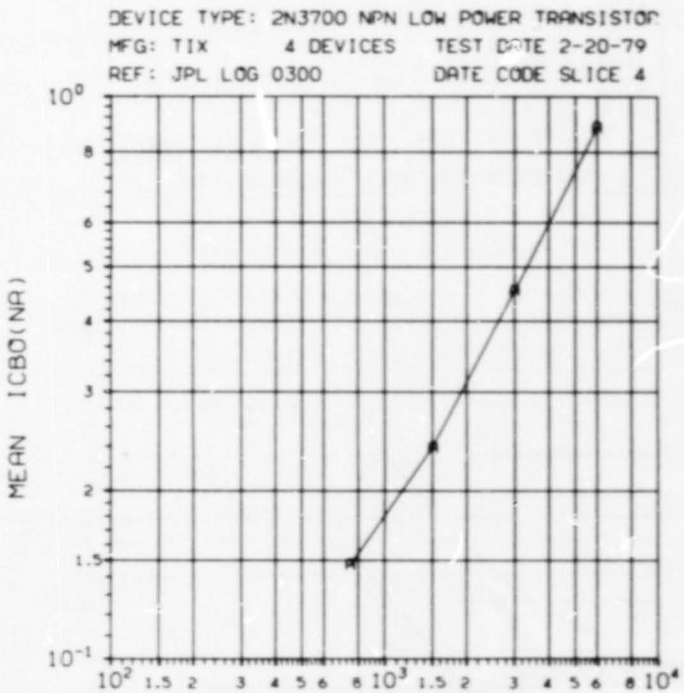
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.000	20.0	.0004	.0005	.0012	.0013
B	1.000	20.0	.0003	.0003	.0013	.0017
C	1.000	.500	.0003	.0003	.0012	.0017
D	10.00	20.0	.0002	.0002	.0004	.0004
E	10.00	.500	.0001	.0002	.0003	.0005



(1) ICBO, VCE=30V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	1.61	4.50
A	.0581	.0648	.0619	.0702

INITIAL MEAN VALUE ICBO(NA) = 1.74×10^{-1}



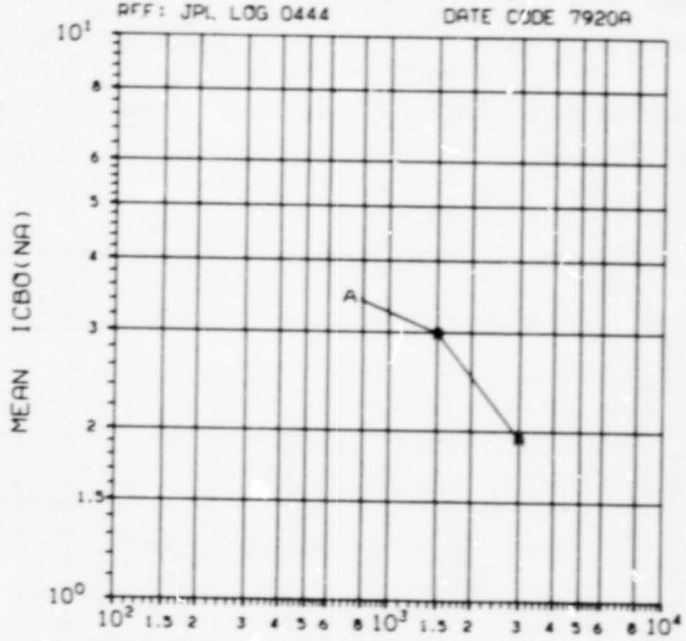
(1) ICBO IN NANOAMPS (VCB=30V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0150	.0275	.0325	.2845

INITIAL MEAN VALUE ICBO(NA) = 9.35×10^{-2}

C-2

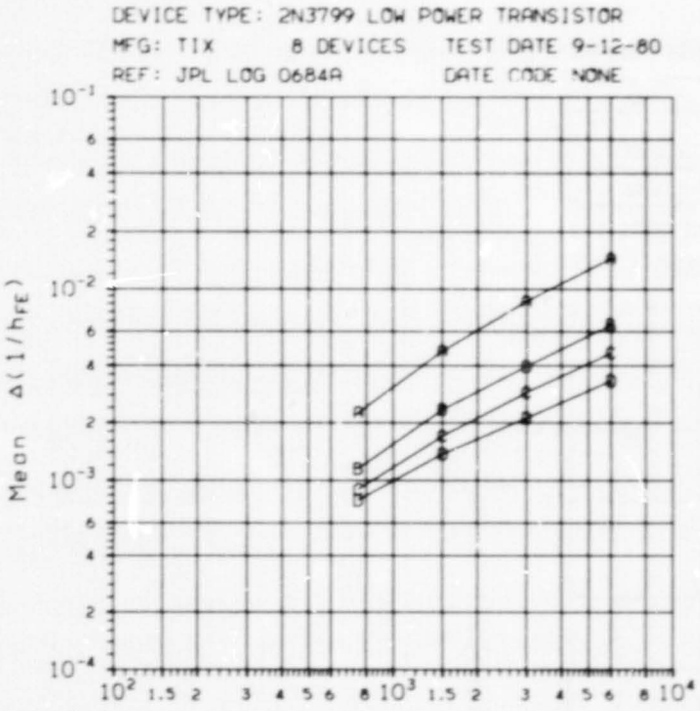
DEVICE TYPE: 2N3700 NPN LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 8-17-79
REF: JPL LOG 0444 DATE CODE 7920A



(1) ICBO IN NA; VCE=30V, IN SITU MEA VS DOSE

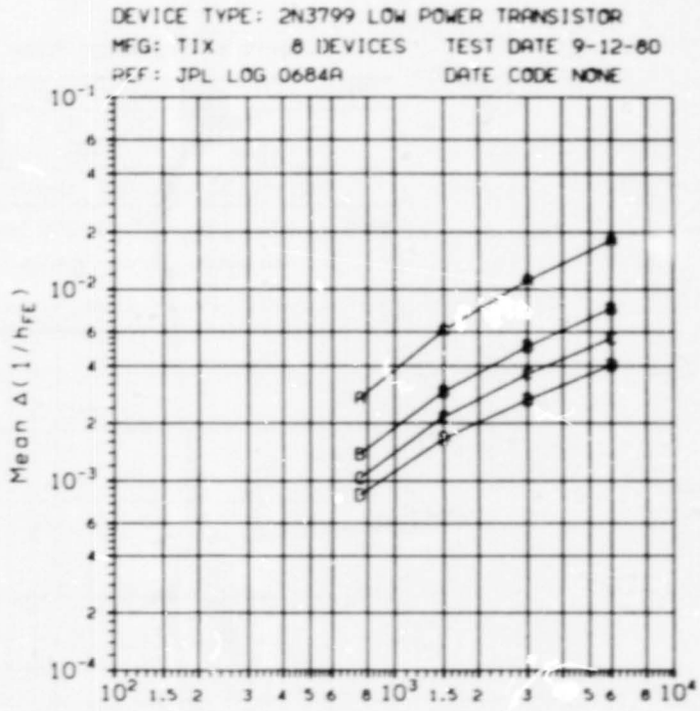
TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00
A	1.460	1.214	.5495

INITIAL MEAN VALUE ICBO(NA) = 6.49×10^0



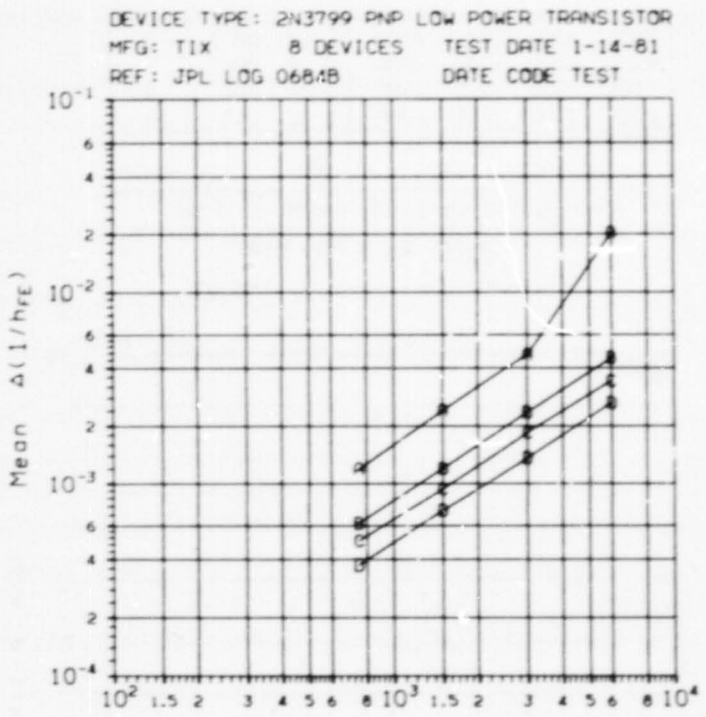
$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.010	20.0	.0035	.0072	.0127	.0181
B	.100	20.0	.0016	.0032	.0052	.0071
C	.300	20.0	.0012	.0023	.0035	.0047
D	1.00	20.0	.0010	.0017	.0024	.0028



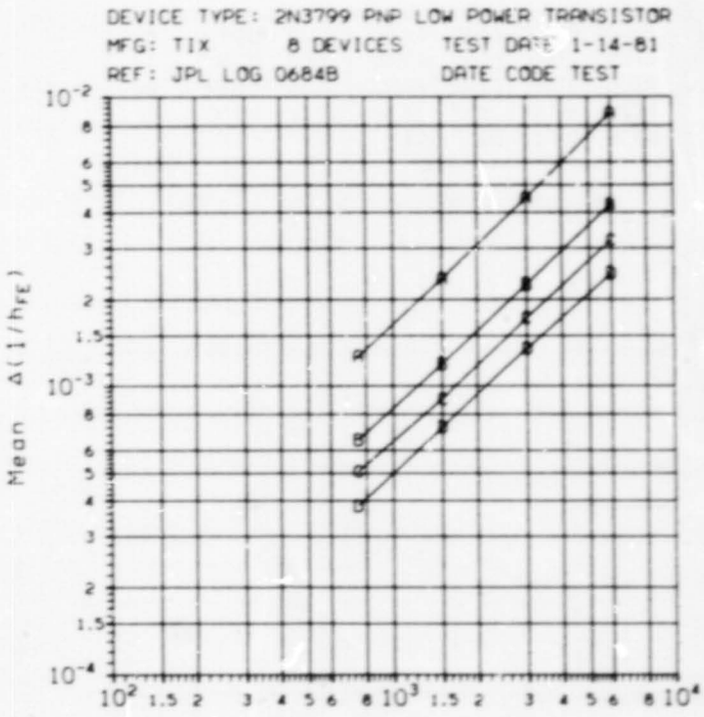
$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.010	20.0	.0029	.0075	.0133	.0197
B	.100	20.0	.0015	.0035	.0057	.0078
C	.300	20.0	.0011	.0025	.0039	.0053
D	1.00	20.0	.0009	.0019	.0028	.0035



Δ(1/h_{FE}) VS DOSE

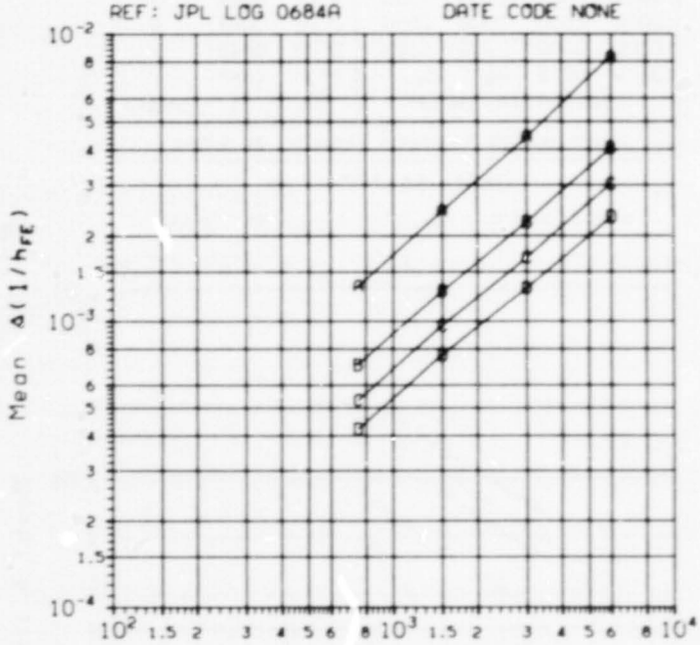
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	20.0	.0001	.0003	.0005	.0302
B	.1000	20.0	.0001	.0001	.0002	.0003
C	.3000	20.0	.0001	.0001	.0003	.0002
D	1.000	20.0	.0000	.0000	.0001	.0001



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	20.0	.0006	.0010	.0015	.0024
B	.1000	20.0	.0003	.0005	.0007	.0011
C	.3000	20.0	.0002	.0003	.0005	.0008
D	1.000	20.0	.0002	.0003	.0004	.0005

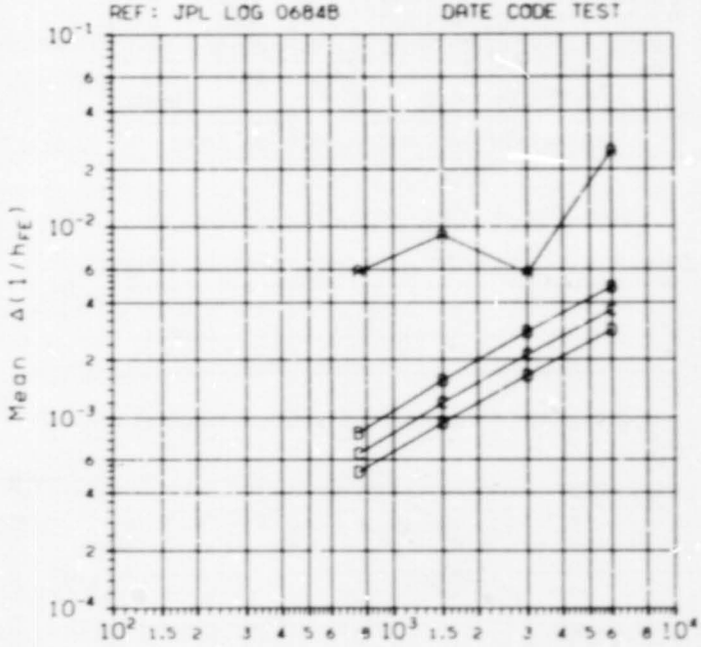
DEVICE TYPE: 2N3799 LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 9-12-80
REF: JPL LOG 0684A DATE CODE NONE



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.010	20.0	.0007	.0010	.0016	.0023
B	.100	20.0	.0003	.0005	.0007	.0011
C	.300	20.0	.0002	.0004	.0005	.0008
D	1.00	20.0	.0002	.0003	.0004	.0006

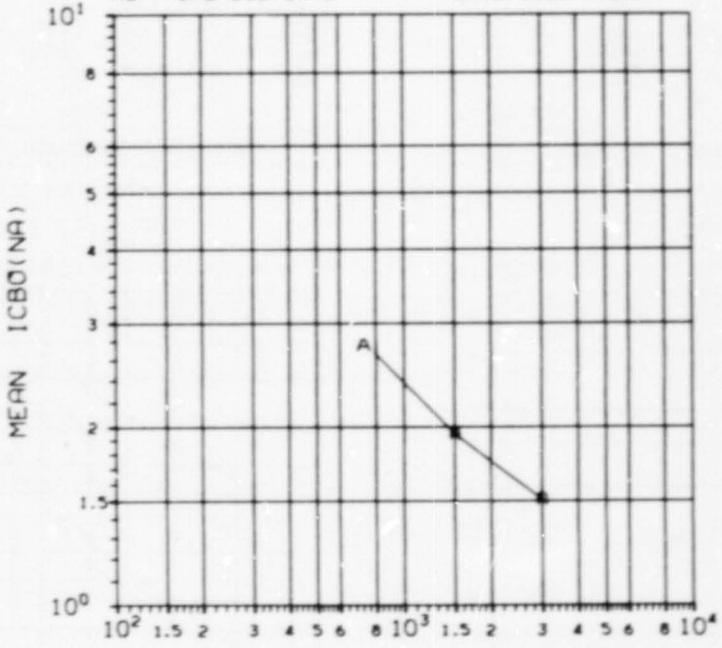
DEVICE TYPE: 2N3799 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 1-14-81
REF: JPL LOG 0684B DATE CODE TEST



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	20.0	.0120	.0167	.0036	.0421
B	.1000	20.0	.0007	.0012	.0016	.0016
C	.3000	20.0	.0005	.0009	.0011	.0012
D	1.000	20.0	.0003	.0007	.0008	.0008

DEVICE TYPE: 2N3799 PNP LOW POWER TRANSISTOR
MFG: TIX 8 DEVICES TEST DATE 8-17-79
REF: JPL LOG 0446 DATE CODE 7920

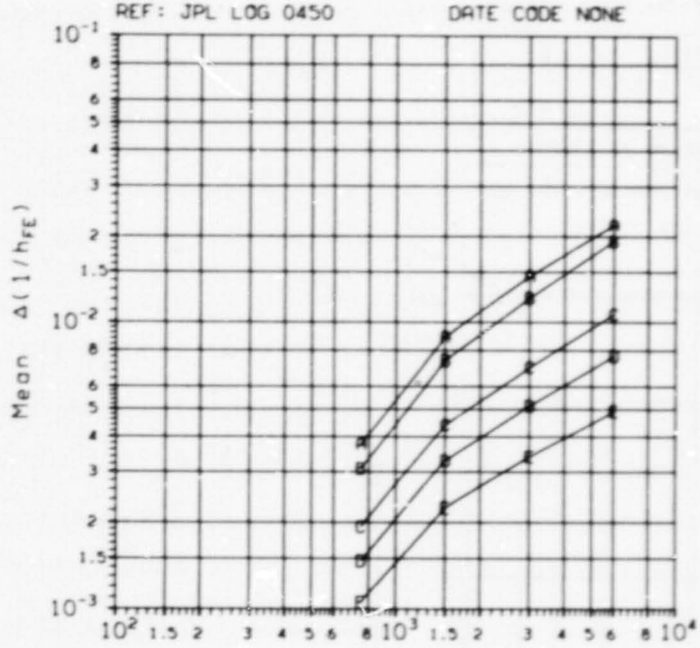


(1) ICBO IN nA; VCB=20V, IN SITU MEA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si)		
	.75	1.50	3.00
A	1.025	.7946	.5659

INITIAL MEAN VALUE ICBO(NA) = 5.54×10^0

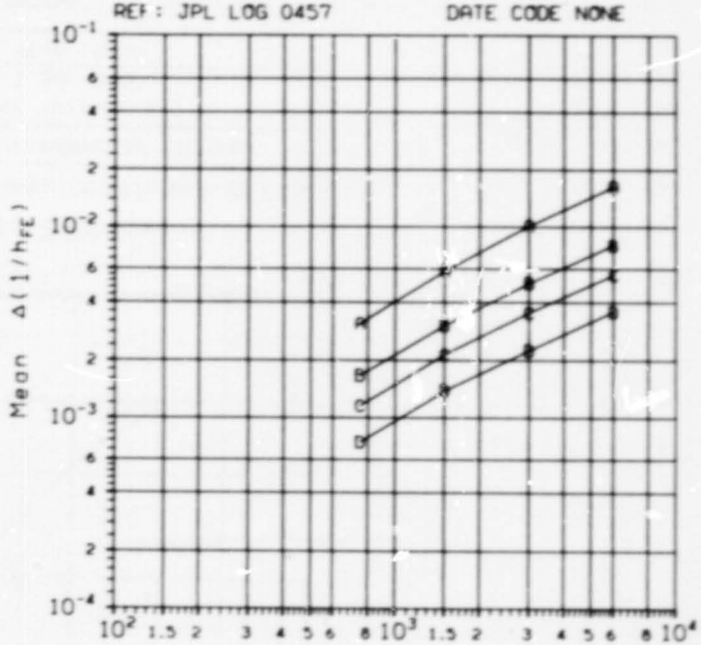
DEVICE TYPE: 2N3805 PNP LOW POWER TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 8-7-79
REF: JPL LOG 0450 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	16.0	.0037	.0102	.0173	.0256
B	.0100	16.0	.0033	.0090	.0147	.0223
C	.0700	16.0	.0021	.0052	.0081	.0118
D	.2000	16.0	.0016	.0039	.0060	.0083
E	1.000	16.0	.0012	.0026	.0038	.0051

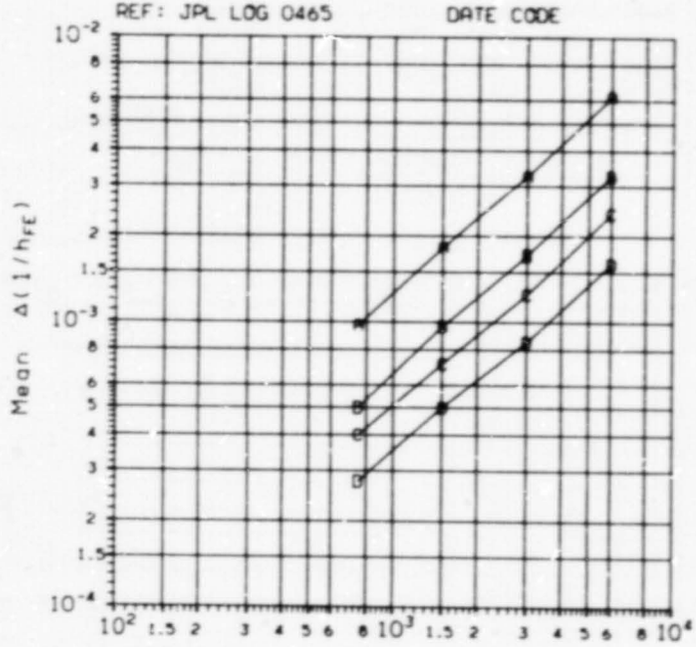
DEVICE TYPE: 2N3805 PNP LOW POWER TRANSISTOR
MFG: TIX 6 DEVICES TEST DATE 8-17-79
REF: JPL LOG 0457 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	16.0	.0038	.0070	.0127	.0194
B	.0700	16.0	.0016	.0036	.0062	.0089
C	.2000	16.0	.0012	.0027	.0045	.0062
D	1.000	16.0	.0008	.0018	.0028	.0038

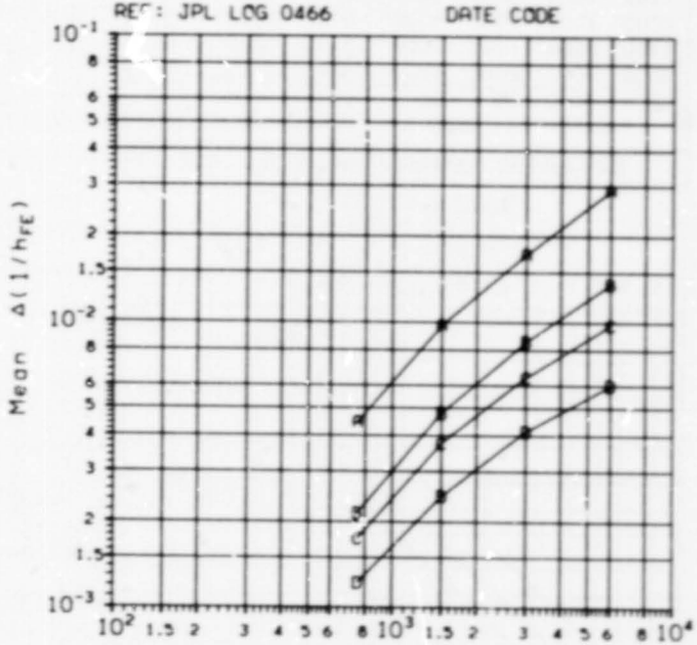
DEVICE TYPE: 2N3805 PNP LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 9-5-79
REF: JPL LOG 0465 DATE CODE



Δ(1/h_{FE}) VS DOSE

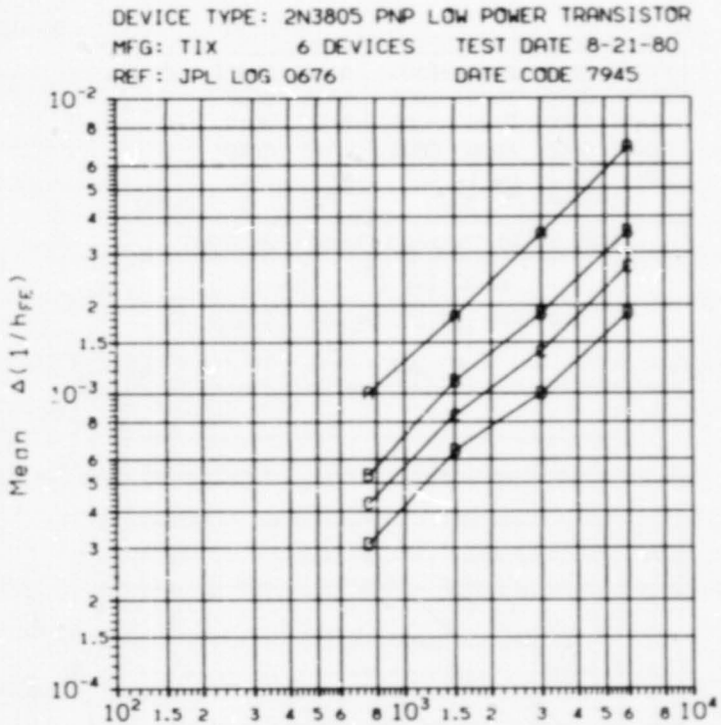
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	16.0	.0002	.0004	.0005	.0008
B	.0700	16.0	.0001	.0002	.0003	.0005
C	.2000	16.0	.0001	.0001	.0002	.0003
D	1.000	16.0	.0001	.0002	.0002	.0003

DEVICE TYPE: 2N3805 PNP LOW POWER TRANSISTOR
MFG: TIX 4 DEVICES TEST DATE 9-5-79
REF: JPL LOG 0466 DATE CODE



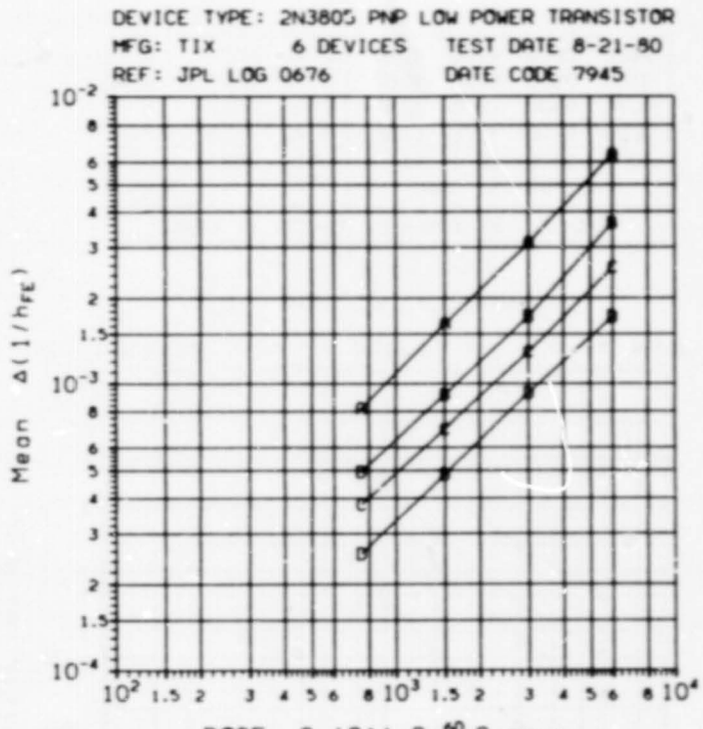
Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	16.0	.0027	.0074	.0136	.0235
B	.0700	16.0	.0014	.0037	.0066	.0108
C	.2000	16.0	.0011	.0028	.0050	.0075
D	1.000	16.0	.0008	.0018	.0032	.0044



$\Delta(1/h_{FE})$ VS DOSE

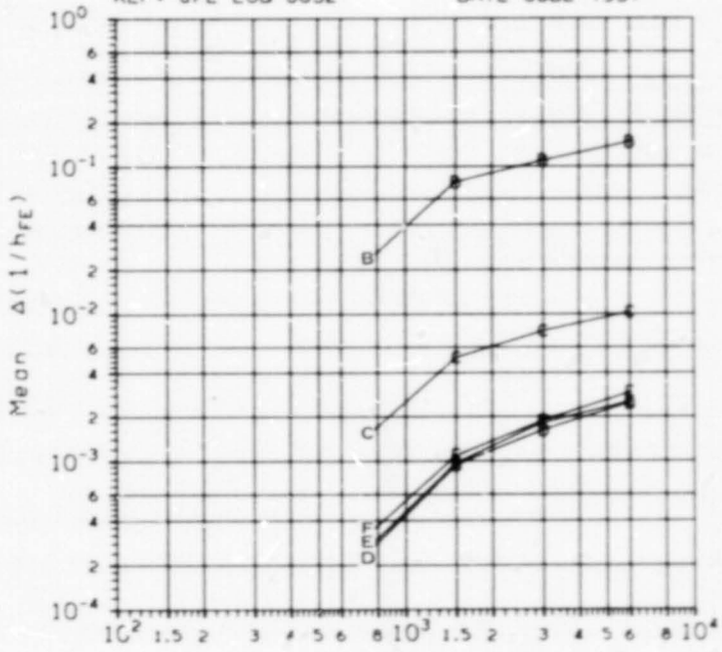
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	16.0	.0002	.0003	.0003	.0005
B	.0700	16.0	.0001	.0003	.0002	.0003
C	.2000	16.0	.0001	.0002	.0001	.0002
D	1.000	16.0	.0001	.0002	.0001	.0002



$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	16.0	.0001	.0002	.0006	.0009
B	.0700	16.0	.0001	.0001	.0002	.0011
C	.2000	16.0	.0001	.0001	.0002	.0003
D	1.000	16.0	.0000	.0000	.0001	.0001

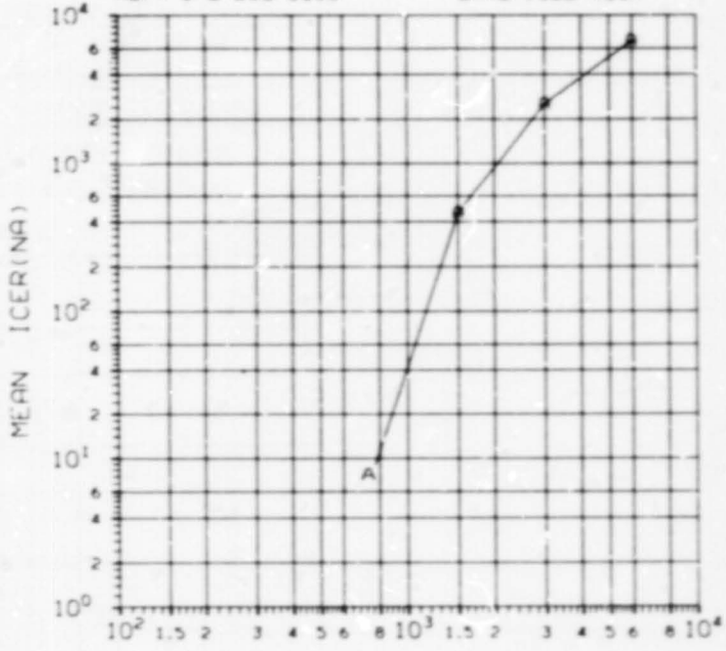
DEVICE TYPE: 2N4150 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 6-14-80
REF: JPL LOG 0652 DATE CODE 7537



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (A)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.0010	5.00	.0079	.0378	.0530	.0763
C	.1000	5.00	.0002	.0011	.0016	.0024
D	1.000	5.00	.0000	.0002	.0003	.0004
E	1.000	1.00	.0000	.0002	.0006	.0004
F	1.000	.600	.0000	.0002	.0003	.0004

DEVICE TYPE: 2N4150 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 6-17-80
REF: JPL LOG 0653 DATE CODE 7537

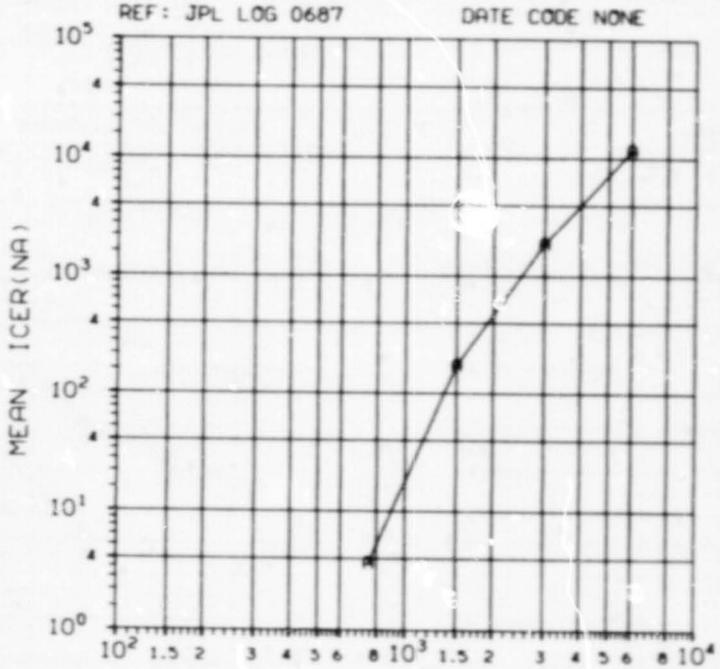


(1) ICER IN NA; VCE=10V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	7.3e6	520.1	3609.	7445.

INITIAL MEAN VALUE ICER(NA) = 1.66×10^{0}

DEVICE TYPE: 2N4150 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 9-15-80
REF: JPL LOG 0687 DATE CODE NONE

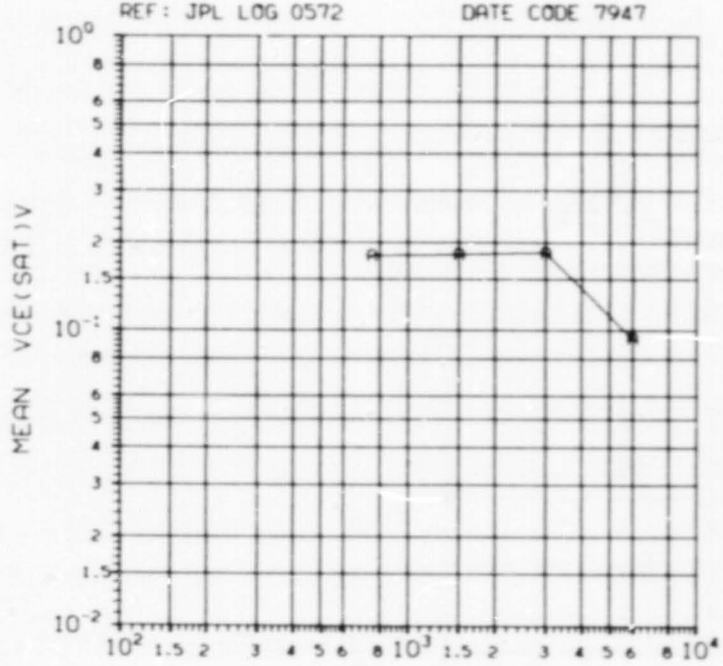


(1) ICER IN NA; VCE=10V: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	6.732	375.0	3263.	

INITIAL MEAN VALUE ICER(NA) = 5.98×10^{-1}

DEVICE TYPE: 2N5663 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 12-17-79
REF: JPL LOG 0572 DATE CODE 7947

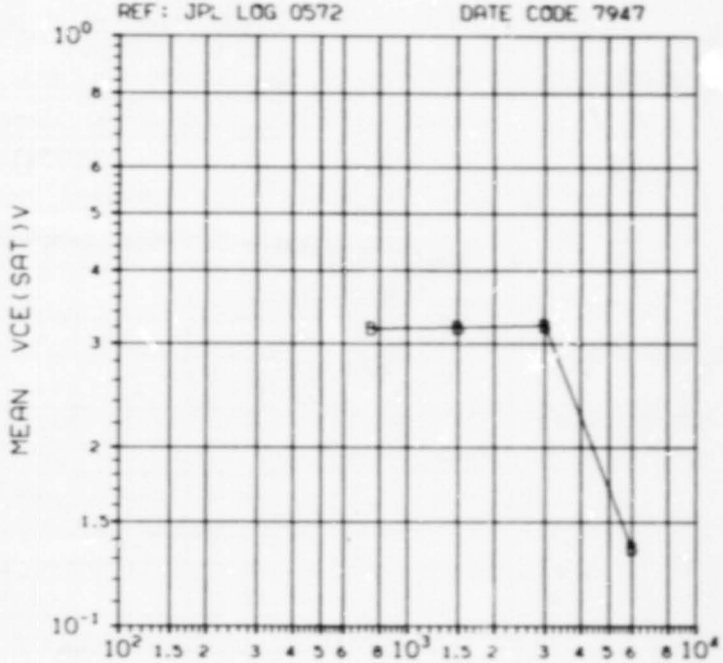


(1) VCESAT(1) IN VOLTS; IC=250MA, IB VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0164	.0160	.0165	.0051

INITIAL MEAN VALUE VCE(SAT)V = 8.06×10^{-2}

DEVICE TYPE: 2N5663 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 12-17-79
REF: JPL LOG 0572 DATE CODE 7947

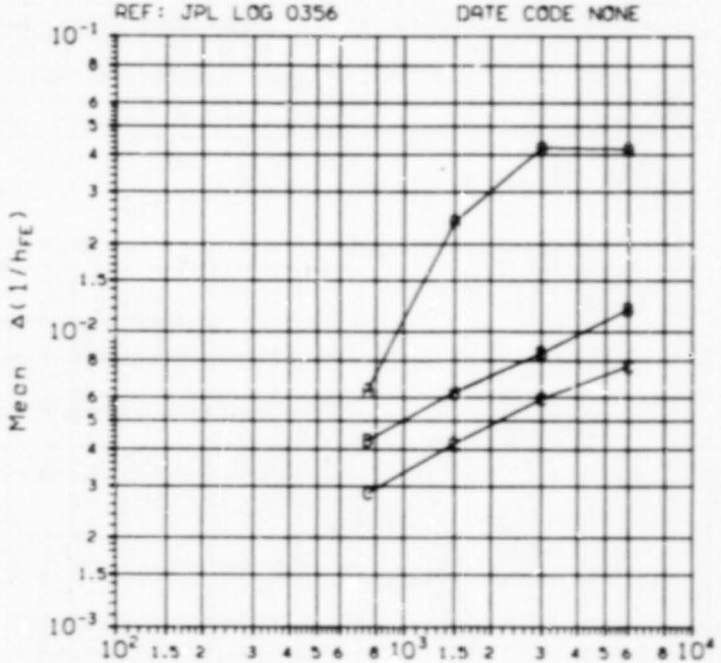


(2) VCESAT(2) IN VOLTS; IC=500MA, IB VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	.0304	.0295	.0302	.0082

INITIAL MEAN VALUE VCE(SAT)V = 1.21×10^{-1}

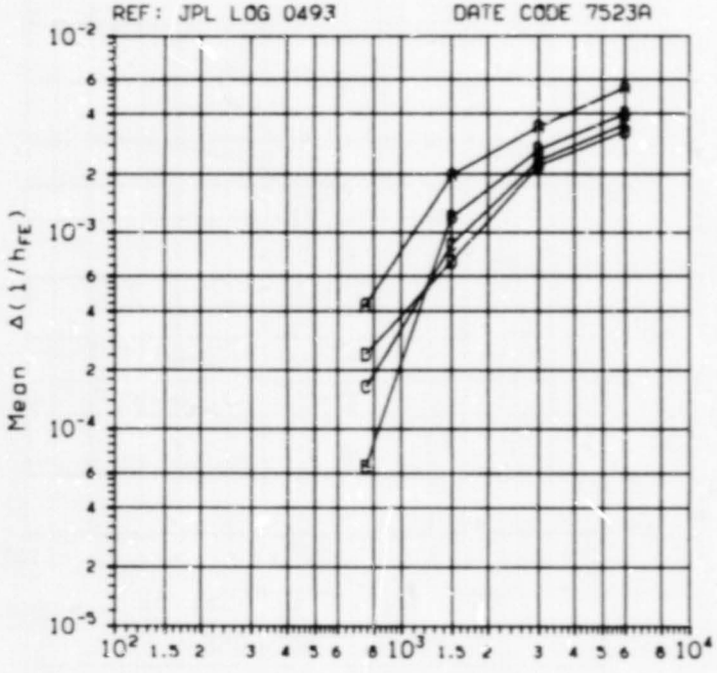
DEVICE TYPE: 14BB101 NPN POWER TRANSISTOR
MFG: SOD 8 DEVICES TEST DATE 4-30-79
REF: JPL LOG 0356 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (A)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.5000	.100	.0057	.0337	.0461	.0084
B	.3750	20.0	.0005	.0008	.0015	.0025
C	3.000	1.00	.0004	.0006	.0012	.0010

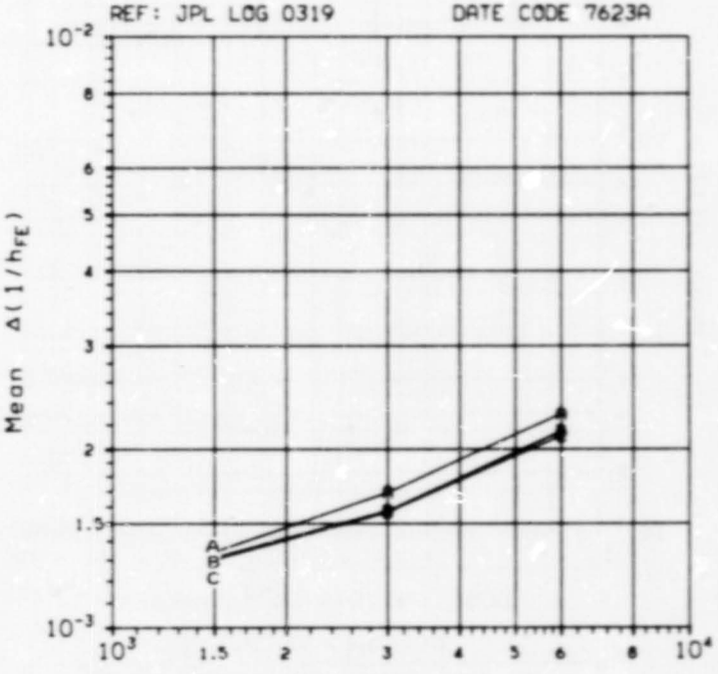
DEVICE TYPE: 79BB128 NPN POWER TRANSISTOR
MFG: SOD 3 DEVICES TEST DATE 10-3-79
REF: JPL LOG 0493 DATE CODE 7523A



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (A)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.000	2.00	.0037	.0037	.0038	.0037
B	2.000	2.00	.0034	.0033	.0034	.0035
C	3.000	2.00	.0033	.0033	.0034	.0036
D	4.000	2.00	.0034	.0033	.0034	.0037

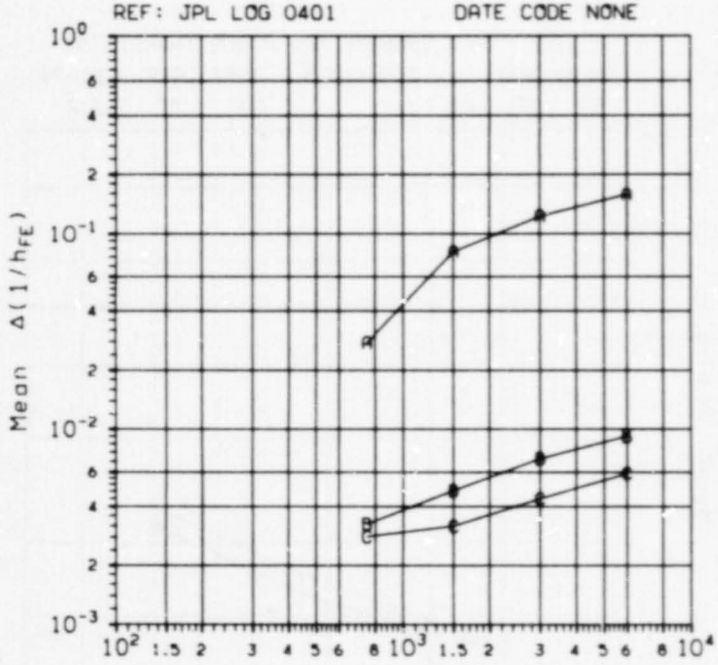
DEVICE TYPE: 79BB128 NPN POWER TRANSISTOR
MFG: SOD 3 DEVICES TEST DATE 3-21-79
REF: JPL LOG 0319 DATE CODE 7623A



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (A)	V_{CE} (v)	DOSE, kiloGy(Si) 1.50	3.00	6.00
A	2.000	2.00	.0004	.0002	.0004
B	3.000	2.00	.0004	.0002	.0004
C	4.000	2.00	.0004	.0002	.0004

DEVICE TYPE: 96SV131 NPN POWER TRANSISTOR
MFG: SOD 6 DEVICES TEST DATE 6-25-79
REF: JPL LOG 0401 DATE CODE NONE

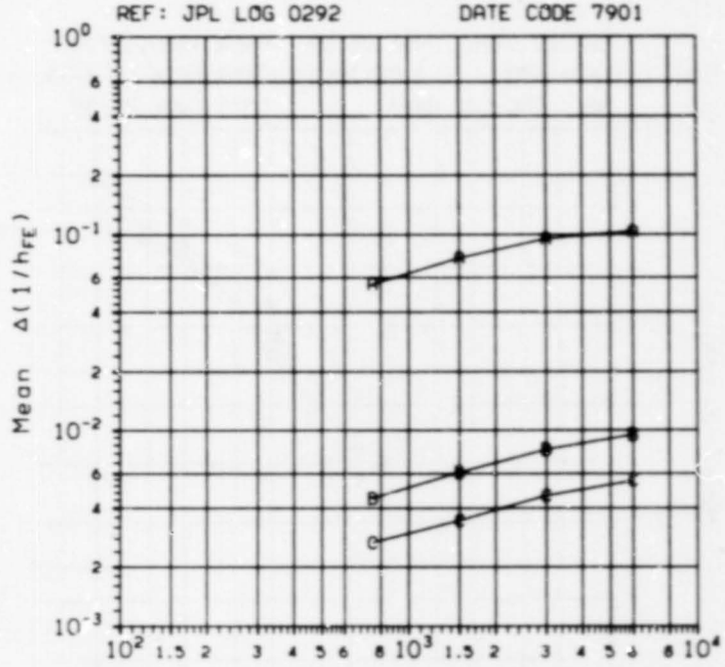


DOSE, Gy(Si) Co^{60} Gammas

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (A)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.000	20.0	.0240	.0451	.0579	.0665
B	4.000	.500	.0009	.0021	.0025	.0027
C	10.00	.500	.0011	.0013	.0013	.0014

DEVICE TYPE: 96SV131 NPN POWER TRANSISTOR
MFG: SOD 3 DEVICES TEST DATE 1-31-79
REF: JPL LOG 0292 DATE CODE 7901

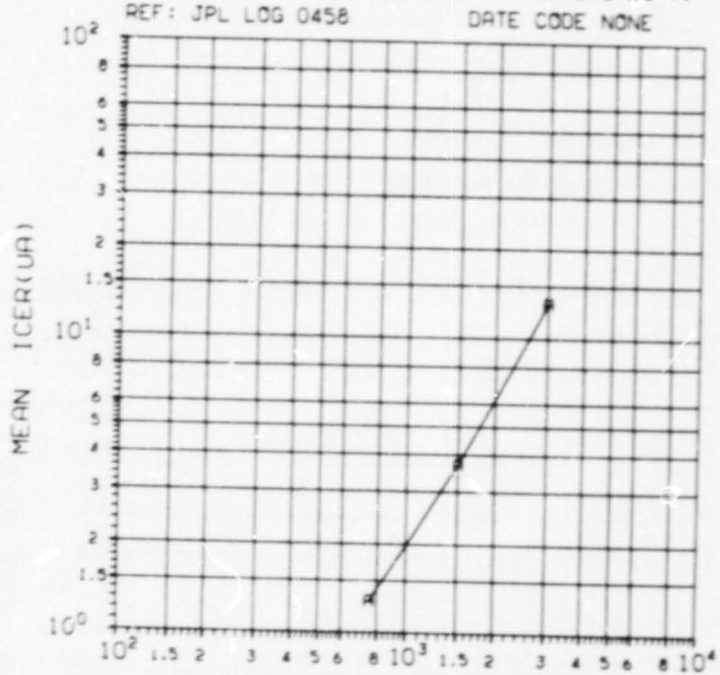


DOSE, Gy(Si) Co^{60} Gammas

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (A)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.1000	20.0	.0294	.0247	.0179	.0093
B	4.000	.500	.0016	.0016	.0015	.0012
C	10.00	.500	.0007	.0008	.0009	.0008

DEVICE TYPE: 965V131 NPN POWER TRANSISTOR
MFG: SOD 3 DEVICES TEST DATE 8-20-79
REF: JPL LOG 0458 DATE CODE NONE

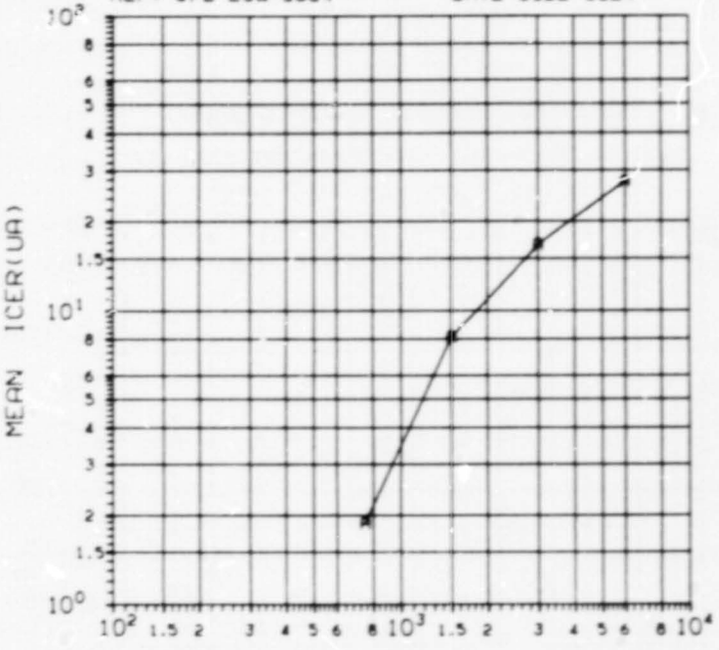


(1) ICER IN UA; VCE=60V, RBE=40HMS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, krlaGy(Si)		
	.75	1.50	3.00
A	.8507	3.275	8.895

INITIAL MEAN VALUE ICER(UA) = 4.54×10^{-2}

DEVICE TYPE: 96SV139 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 6-25-80
REF: JPL LOG 0664 DATE CODE 8024

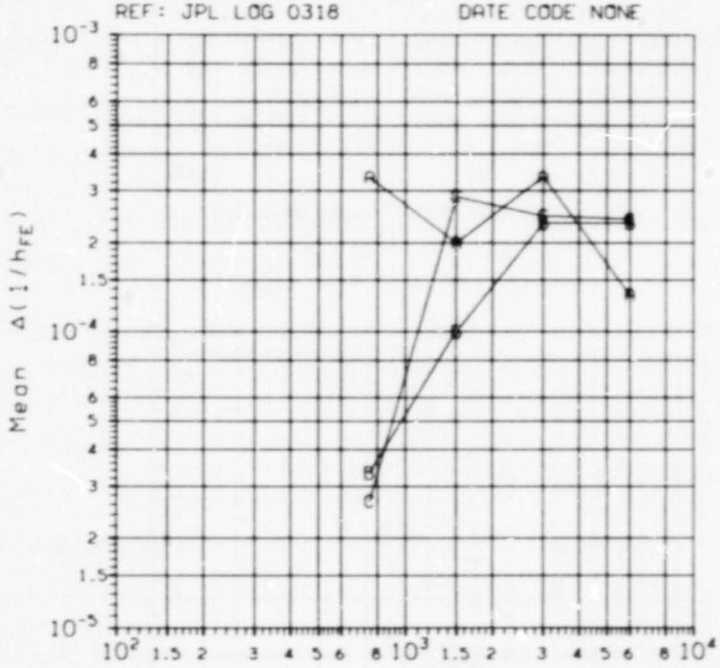


(1) ICER IN UA, VCE=60V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	3.002	11.44	23.36	40.72

INITIAL MEAN VALUE ICER(UA) = 2.25×10^{-2}

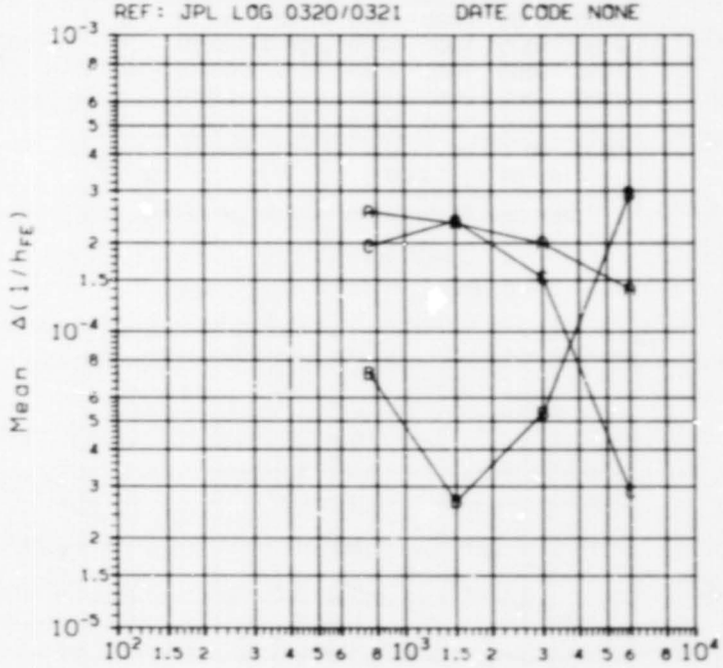
DEVICE TYPE: AT17A NPN LOW POWER TRANSISTOR
MFG: AVA 3 DEVICES TEST DATE 4-9-79
REF: JPL LOG 0318 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.5000	6.00	.0002	.0007	.0008	.0012
B	1.000	6.00	.0002	.0005	.0007	.0012
C	5.000	6.00	.0003	.0005	.0007	.0010

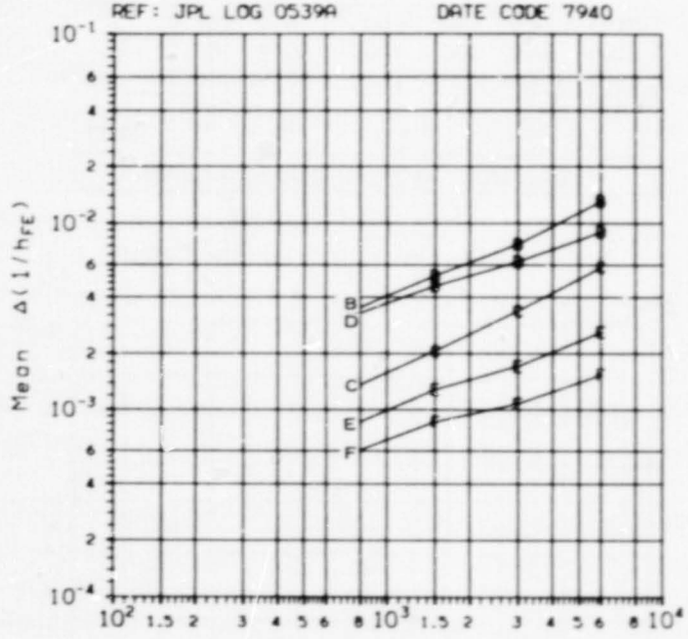
DEVICE TYPE: AT371 NPN LOW POWER TRANSISTOR
MFG: AVA 4 DEVICES TEST DATE 4-12-79
REF: JPL LOG 0320/0321 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	50.00	9.00	.0002	.0001	.0003	.0004
B	100.0	9.00	.0002	.0003	.0002	.0001
C	150.0	9.00	.0004	.0005	.0006	.0006

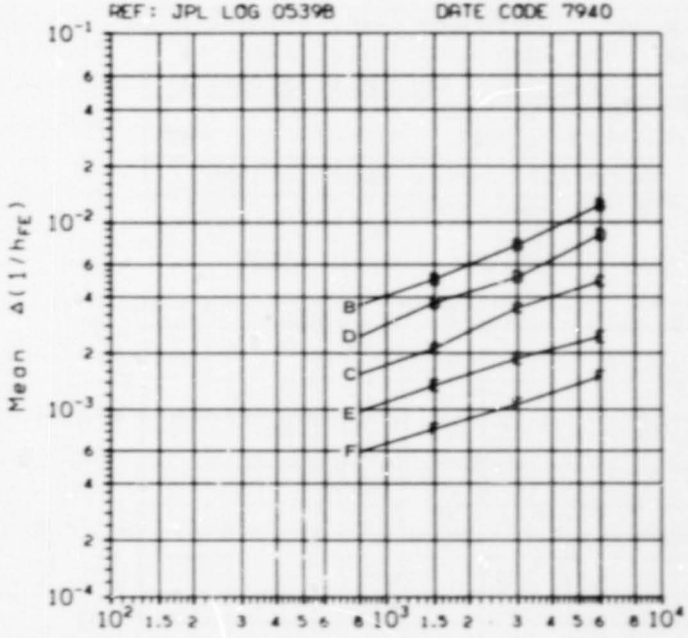
DEVICE TYPE: MQ2219 QUAD NPN TRANSISTOR
MFG: MOT 8 DEVICES TEST DATE 11-16-79
REF: JPL LOG 0539A DATE CODE 7940



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	2.000	.100	.0004	.0004	.0005	.0007
C	2.000	2.40	.0003	.0002	.0002	.0007
D	10.00	.100	.0003	.0005	.0008	.0006
E	10.00	2.40	.0000	.0001	.0001	.0001
F	40.00	.250	.0000	.0001	.0001	.0001

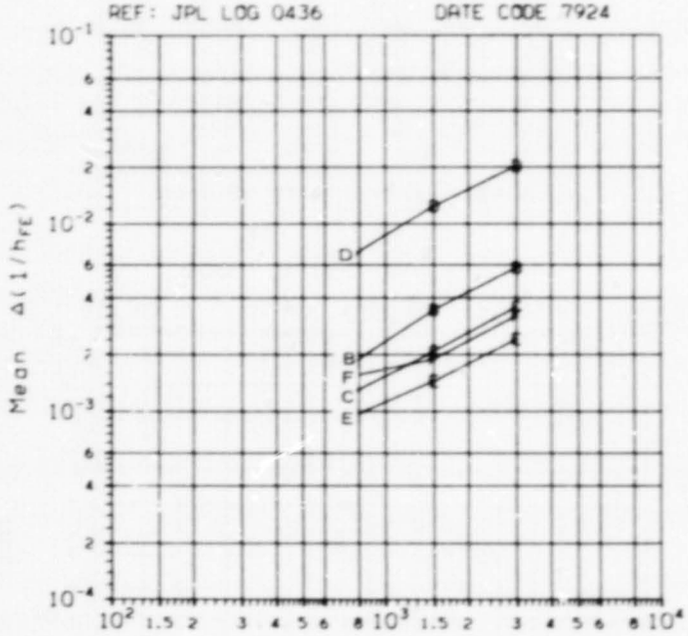
DEVICE TYPE: MQ2219 QUAD NPN TRANSISTOR
MFG: MOT 4 DEVICES TEST DATE 11-16-79
REF: JPL LOG 0539B DATE CODE 7940



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	2.000	.100	.0000	.0000	.0003	.0005
C	2.000	2.40	.0000	.0002	.0000	.0003
D	10.00	.100	.0002	.0001	.0002	.0001
E	10.00	2.40	.0001	.0001	.0001	.0001
F	40.00	.250	.0000	.0000	.0000	.0000

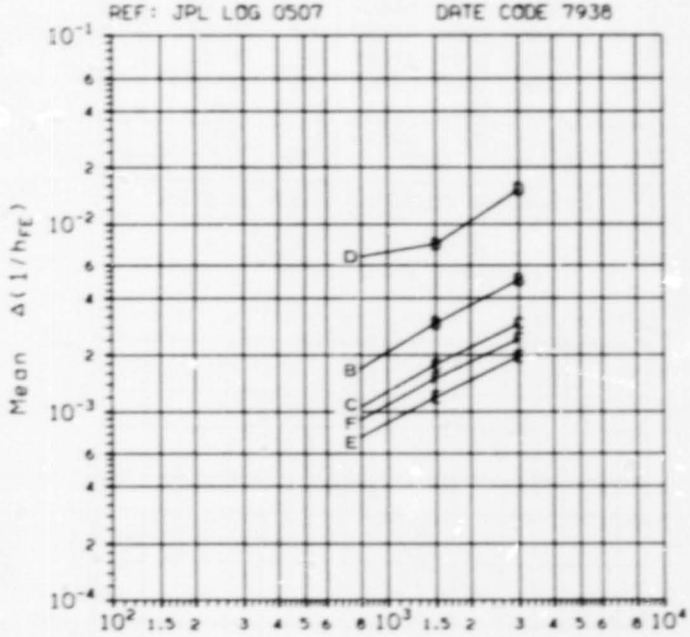
DEVICE TYPE: MQ2905 QUAD PNP TRANSISTOR
MFG: MOT 8 DEVICES TEST DATE 7-24-79
REF: JPL LOG 0436 DATE CODE 7924



Δ(1/h_{FE}) VS DOSE

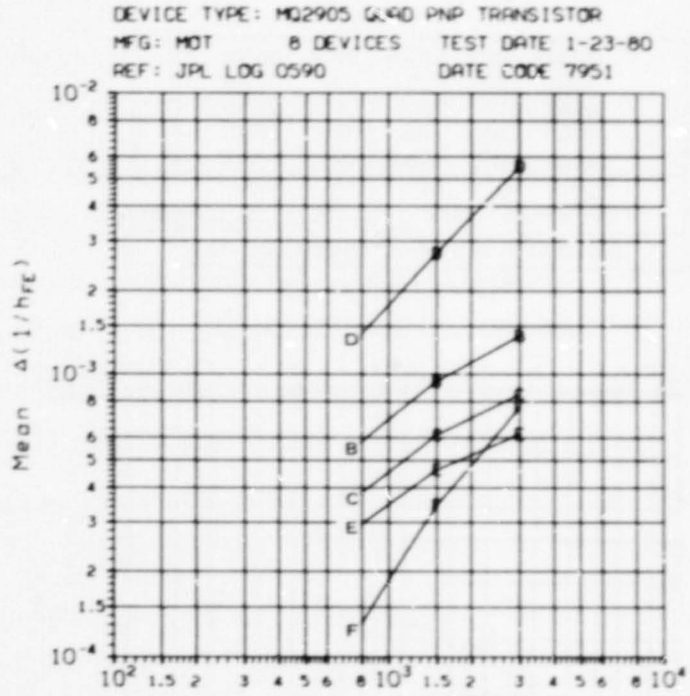
TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
B	2.000	2.40	.0005	.0002	.0004
C	10.00	.100	.0001	.0001	.0002
D	10.00	2.40	.0004	.0009	.0008
E	40.00	.250	.0001	.0001	.0001
F	40.00	2.40	.0013	.0002	.0001

DEVICE TYPE: MQ2905 QUAD PNP TRANSISTOR
MFG: MOT 8 DEVICES TEST DATE 10-26-79
REF: JPL LOG 0507 DATE CODE 7938



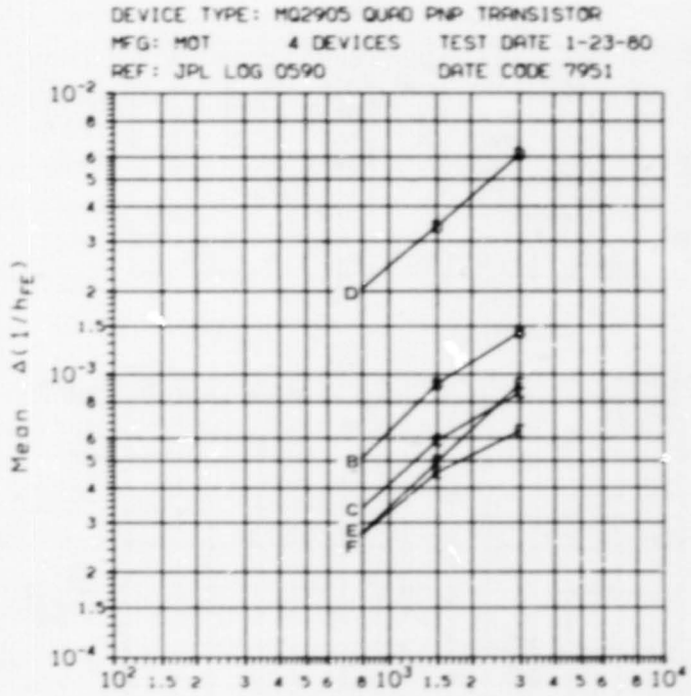
Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
B	2.000	2.40	.0003	.0002	.0004
C	10.00	.100	.0001	.0001	.0001
D	10.00	2.40	.0007	.0080	.0011
E	40.00	.250	.0001	.0001	.0001
F	40.00	2.40	.0001	.0002	.0002



$\Delta(1/h_{FE})$ VS DOSE

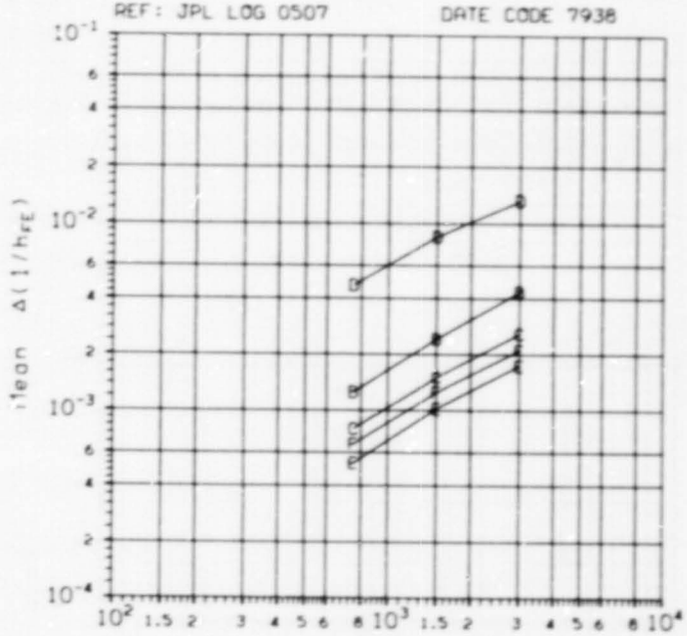
TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
B	2.000	2.40	.0000	.0000	.0001
C	10.00	.100	.0000	.0000	.0001
D	10.00	2.40	.0012	.0012	.0012
E	40.00	.250	.0000	.0000	.0000
F	40.00	2.40	.0003	.0003	.0003



$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
B	2.000	2.40	.0001	.0001	.0002
C	10.00	.100	.0001	.0001	.0001
D	10.00	2.40	.0003	.0003	.0004
E	40.00	.250	.0000	.0000	.0001
F	40.00	2.40	.0000	.0001	.0001

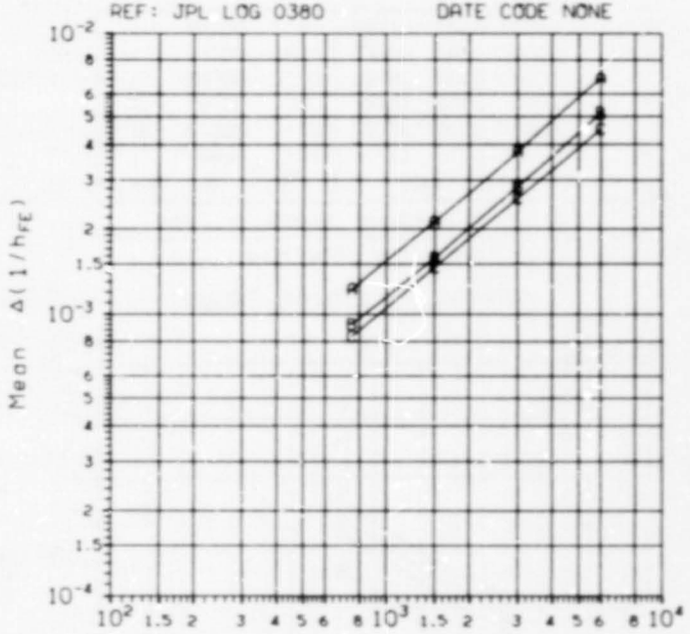
DEVICE TYPE: MQ2905 QUAD PNP TRANSISTOR
MFG: MOT 4 DEVICES TEST DATE 10-26-79
REF: JPL LOG 0507 DATE CODE 7938



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00
[illegible]	2.000	2.40	.0004	.0005	.0007
C	10.00	.100	.0000	.0001	.0001
D	10.00	2.40	.0002	.0002	.0004
E	40.00	.250	0000	.0001	.0000
F	40.00	2.40	.0000	.0000	.0001

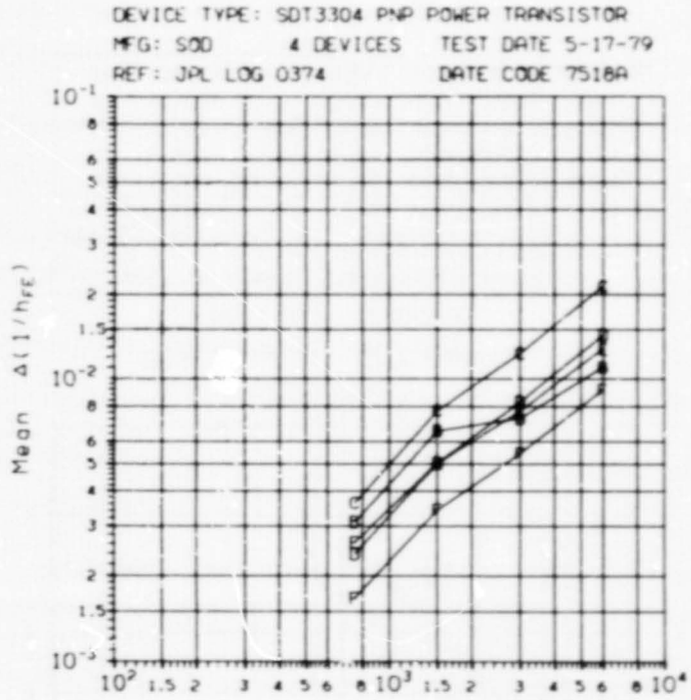
DEVICE TYPE: SDT3303 PNP POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 5-17-79
REF: JPL LOG 0380 DATE CODE NONE



DOSE, Gy(Si) Co^{60} Gammas

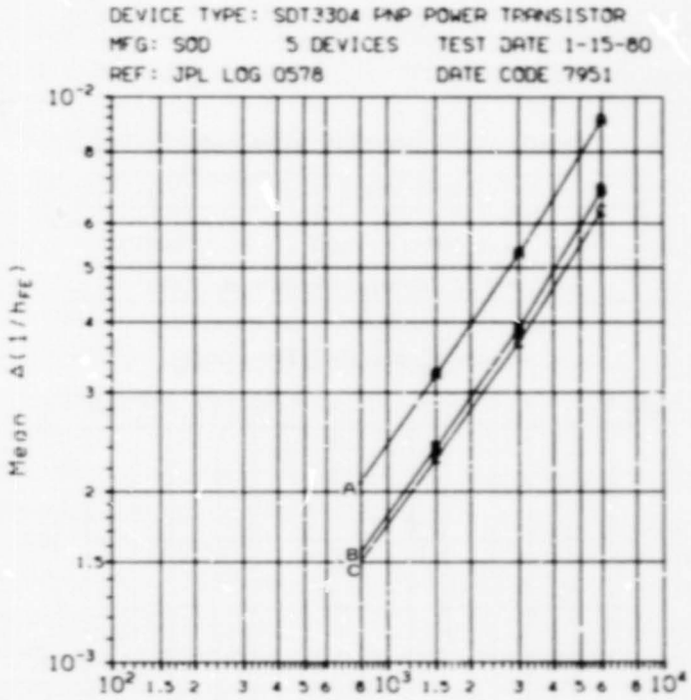
$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (A)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	2.00	.0005	.0009	.0012	.0020
B	.1000	2.00	.0004	.0007	.0009	.0015
C	1.000	2.00	.0003	.0005	.0008	.0012



Δ(1/h_{FE}) VS DOSE

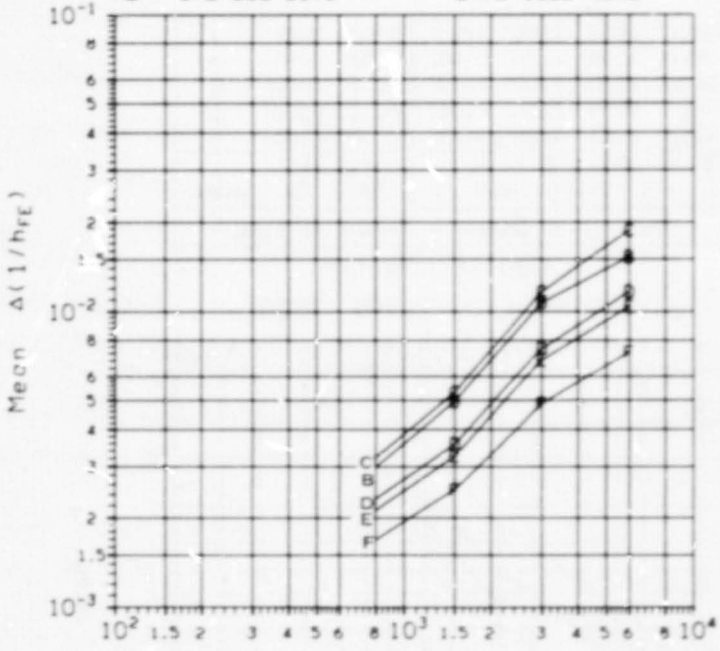
TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (A)	V_{CE} (V)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	.0010	20.0	.0016	.0031	.0078	.0125
C	.0010	1.00	.0013	.0023	.0036	.0056
D	.0100	1.00	.0012	.0019	.0027	.0035
E	.0100	20.0	.0010	.0017	.0027	.0038
F	.1000	20.0	.0021	.0025	.0029	.0035



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (A)	V_{CE} (V)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	2.00	.0005	.0007	.0011	.0015
B	.1000	2.00	.0004	.0005	.0008	.0011
C	1.000	2.00	.0004	.0006	.0008	.0012

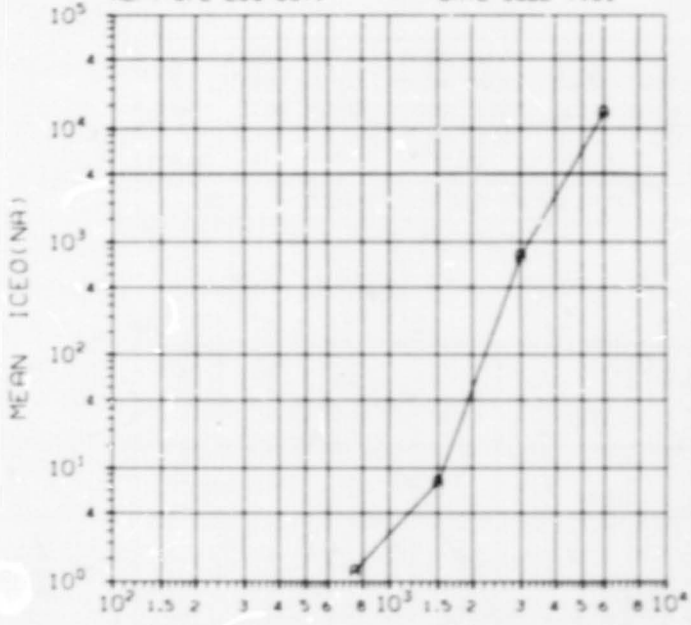
DEVICE TYPE: SDT3304 PNP POWER TRANSISTOR
MFG: SOL 5 DEVICES TEST DATE 1-31-80
REF: JPL LOG 0595 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (mA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	1.000	20.0	.0008	.0013	.0022	.0026
C	1.000	1.00	.0009	.0014	.0023	.0028
D	10.00	1.00	.0006	.0009	.0013	.0016
E	10.00	20.0	.0006	.0008	.0013	.0014
F	100.0	20.0	.0004	.0006	.0008	.0009

DEVICE TYPE: SDT3304 PNP POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 1-15-80
REF: JPL LOG 0579 DATE CODE 7951

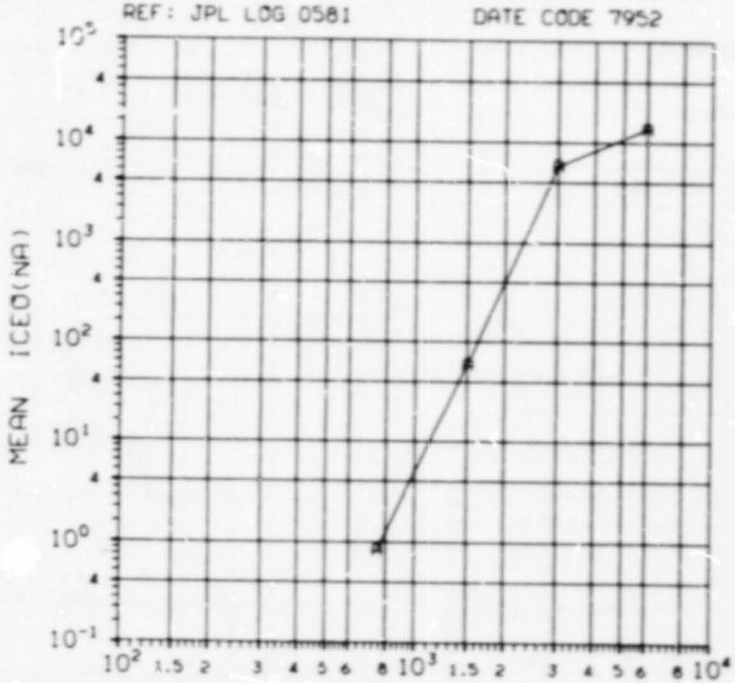


(1) ICEO IN NA; VCEO=30V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	1.191	9.482	1036.	

INITIAL MEAN VALUE ICEO(NA) = 1.22×10^0

DEVICE TYPE: SDT3304 PNP POWER TRANSISTOR
MFG: SOD 4 DEVICES TEST DATE 1-18-80
REF: JPL LOG 0581 DATE CODE 7952

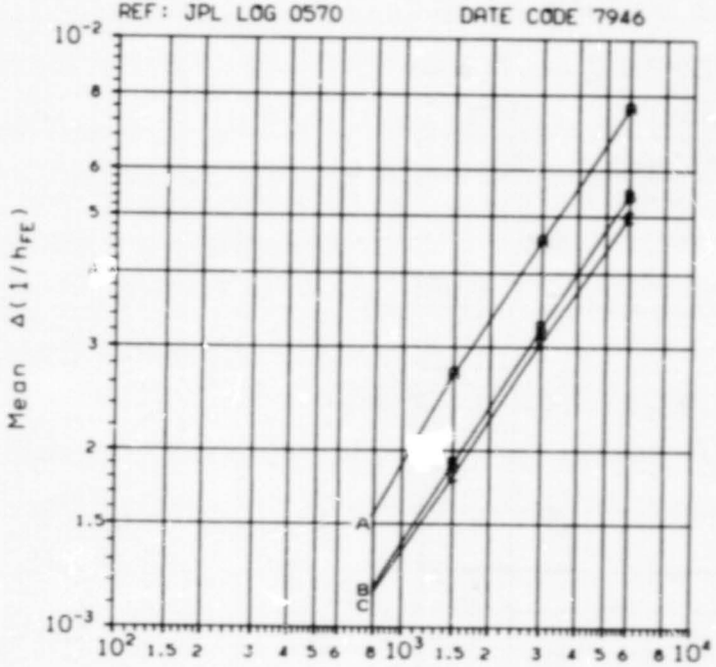


(1) ICEO IN NA; VCEO=30V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kiloGy(Si) .75 1.50 3.00 6.00
A	.1497 41.55 2219. 4614.

INITIAL MEAN VALUE ICEO(NA) = 9.30×10^{-2}

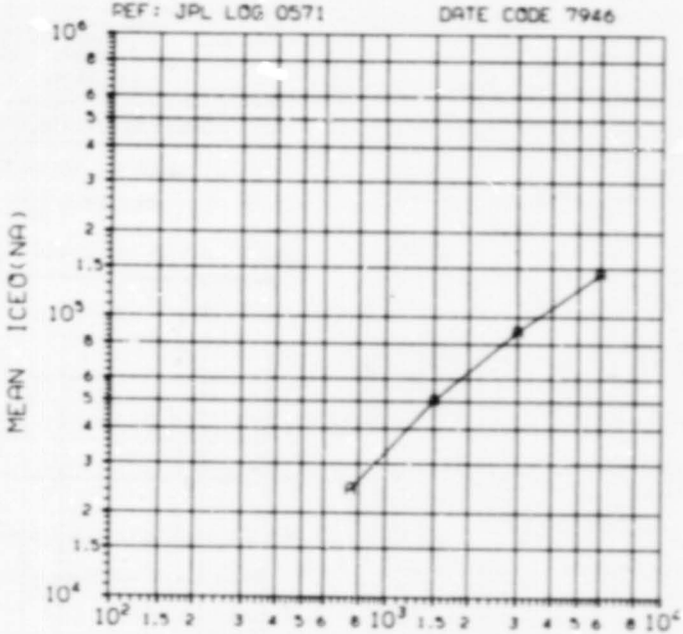
DEVICE TYPE: SDT3323 PNP POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 12-13-79
REF: JPL LOG 0570 DATE CODE 7946



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (A)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0100	2.00	.0005	.0007	.0010	.0015
B	.1000	2.00	.0004	.0005	.0008	.0011
C	1.000	2.00	.0004	.0005	.0008	.0011

DEVICE TYPE: SDT3323 PNP POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 12-14-79
REF: JPL LOG 0571 DATE CODE 7946

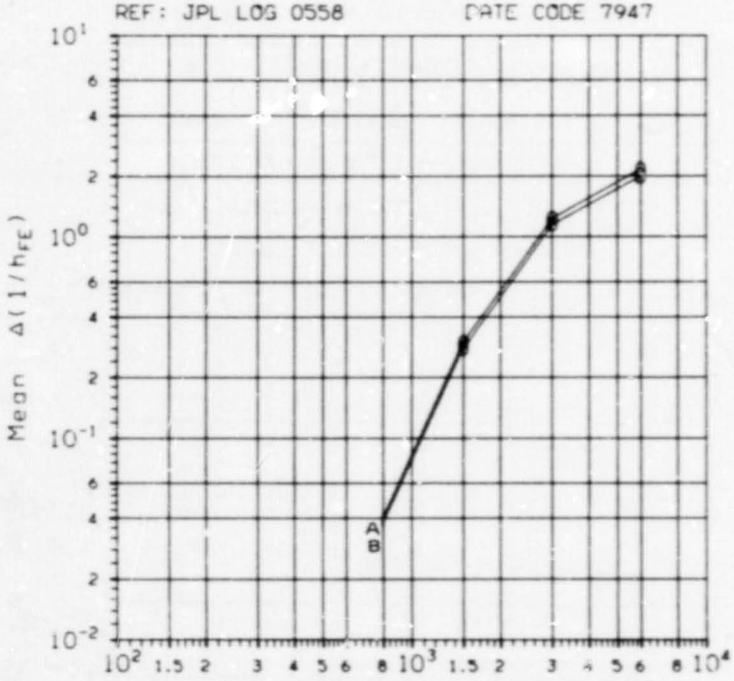


(1) ICEO IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	NOT AVAILABLE			

INITIAL MEAN VALUE ICEO(NA) = 1.29×10^0

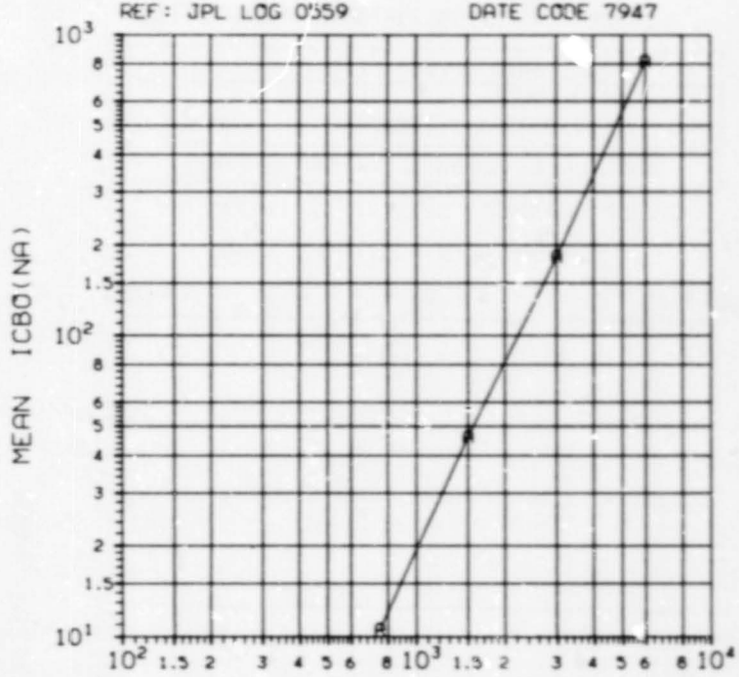
DEVICE TYPE: SDT5553 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 12-10-79
REF: JPL LOG 0558 DATE CODE 7947



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_C (μA)	V_{CE} (v)	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	100.0	2.00	.0216	.0893	.3266	.4743
B	100.0	2.00	.0198	.0648	.3060	.4963

DEVICE TYPE: SDT5553 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 12-6-79
REF: JPL LOG 0559 DATE CODE 7947

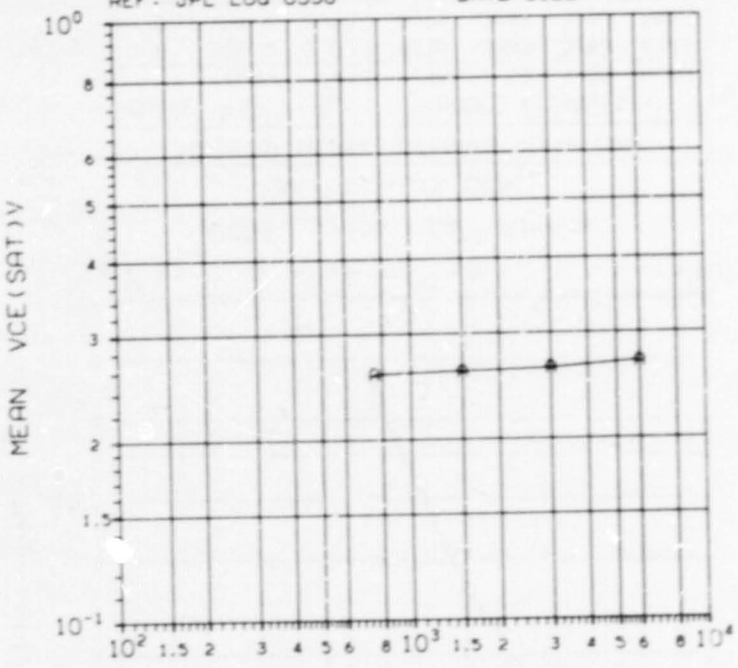


(1) ICBO IN NA; VCB=126V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	10.31	79.48	252.3	555.2

INITIAL MEAN VALUE ICBO(NA) = 3.61×10^0

DEVICE TYPE: SDT5553 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 12-10-79
REF: JPL LOG 0558 DATE CODE 7947

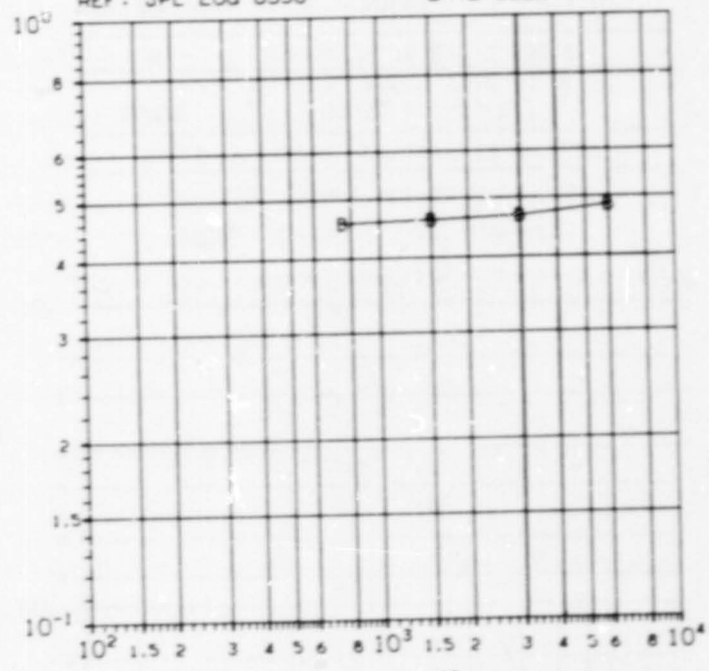


(1) VCESAT(1) IN VOLTS; IC=250MA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0166	.0181	.0177	.0194

INITIAL MEAN VALUE VCE(SAT)V = 1.93×10^{-1}

DEVICE TYPE: SDT5553 NPN POWER TRANSISTOR
MFG: SOD 5 DEVICES TEST DATE 12-10-79
REF: JPL LOG 0558 DATE CODE 7947



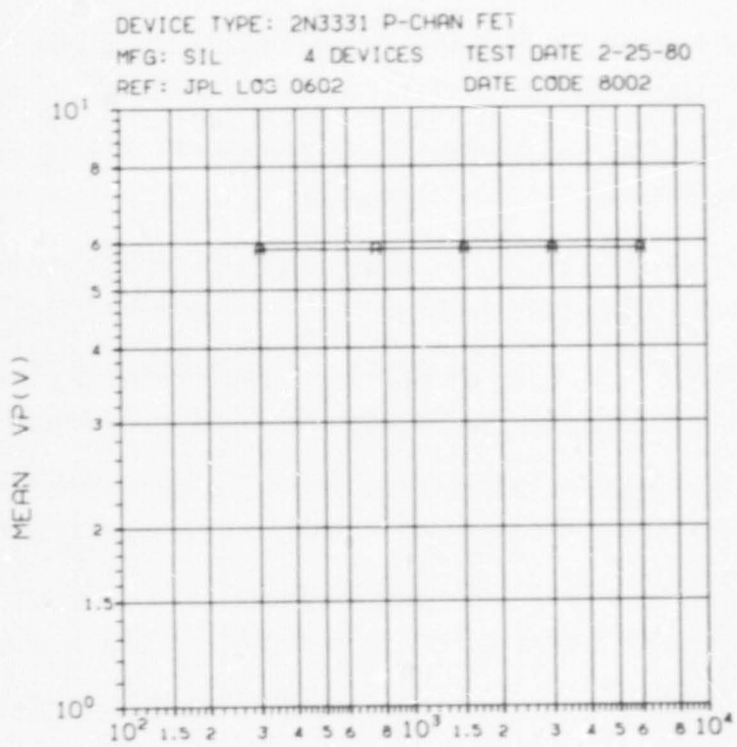
(2) VCESAT(2) IN VOLTS; IC=500MA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	.0432	.0433	.0449	.0534

INITIAL MEAN VALUE VCE(SAT)V = 3.30×10^{-1}

D. FIELD EFFECT TRANSISTORS (FETs)

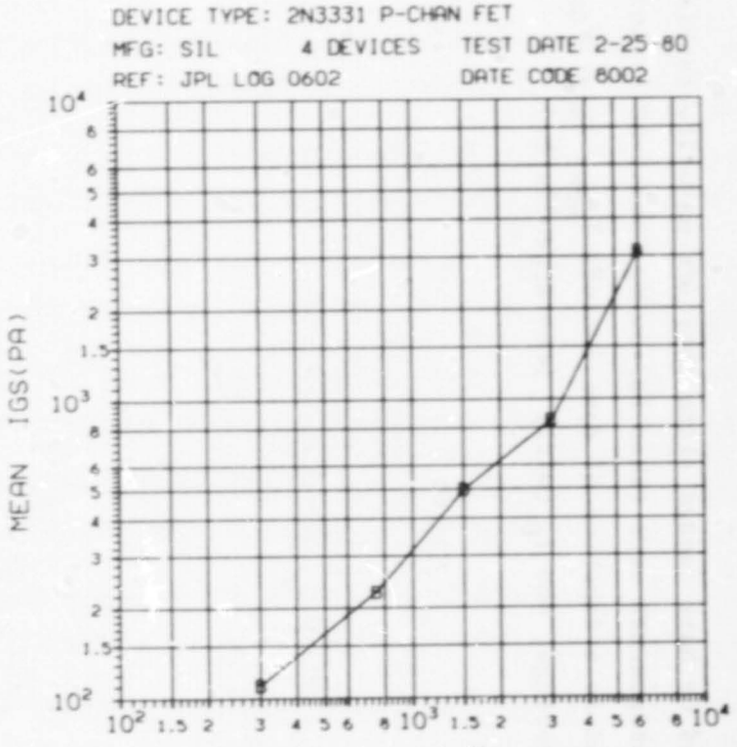
FETs are not affected by bulk damage since they are majority carrier devices. Hence, most measurements were taken following Cobalt-60 irradiation. The key parameters plotted as a function of dose include I_{GSS}, I_{DSS}, V_{GS}, transconductance, noise voltage, and I_D (off). (See Appendix B.)



(1) VP; VDS=-15V, ID=10UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
A	.2224	.2234	.2203	.2218	.2244

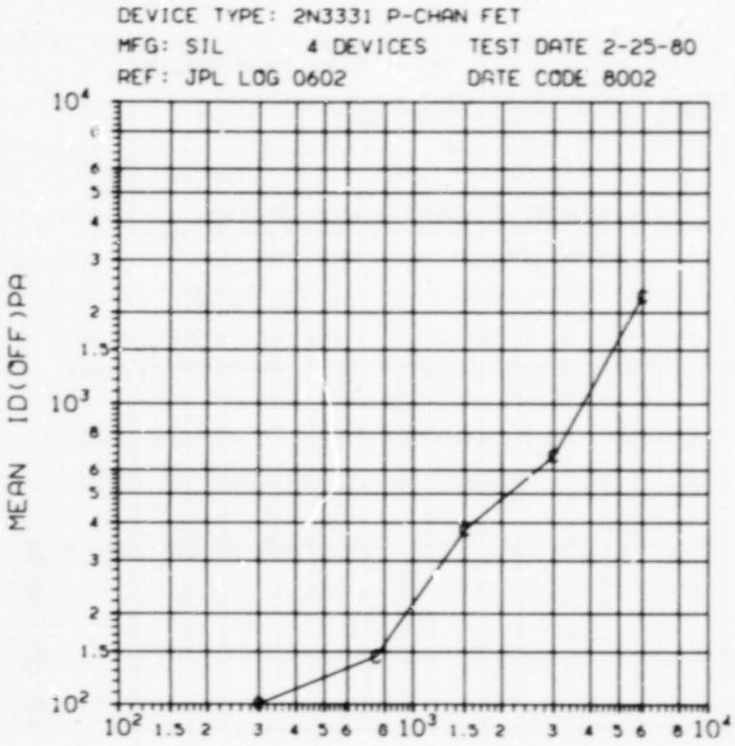
INITIAL MEAN VALUE VP(V) = 5.85×10^{0}



(2) IGS; VDS=0, VGS=+15V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
B	43.00	104.6	80.05	89.85	386.0

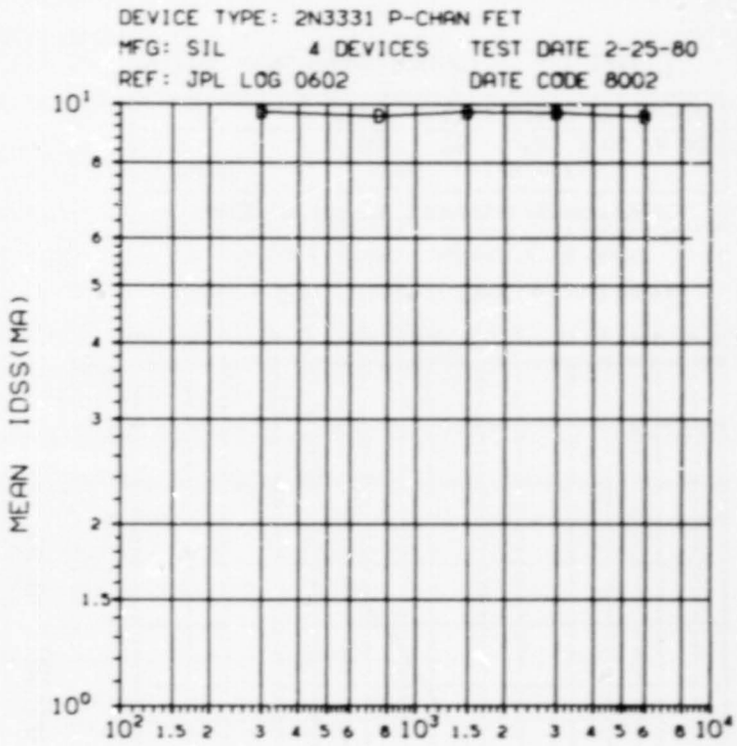
INITIAL MEAN VALUE IGS(PA) = $1.76 \times 10^{+1}$



(3) ID(OFF); VGS=+15V, VDS=-15V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
C	35.30	62.55	70.40	75.65	248.4

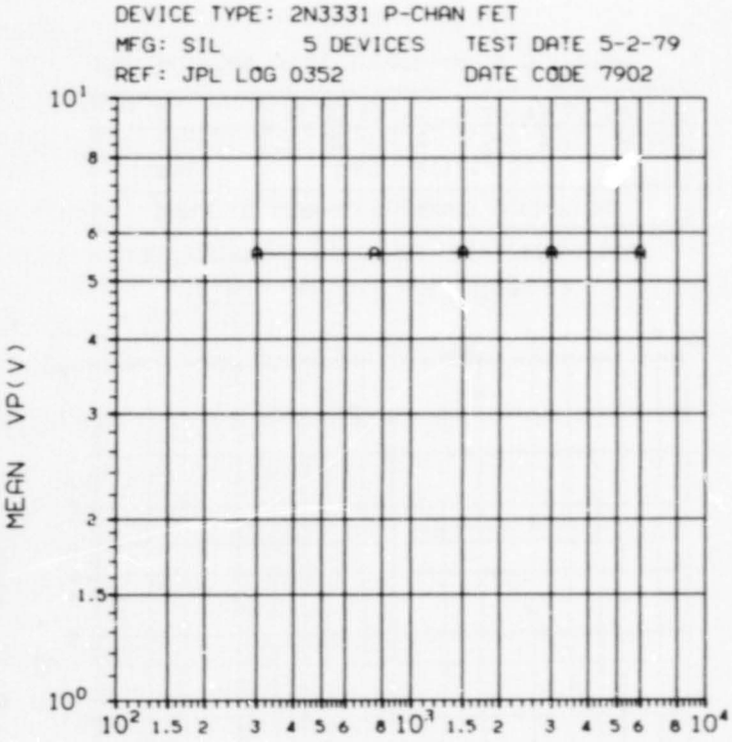
INITIAL MEAN VALUE ID(OFF)PA = $5.43 \times 10^{+1}$



(4) IDSS; VGS=0, VDS=-15V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
D	.4580	.4668	.4697	.4270	.4564

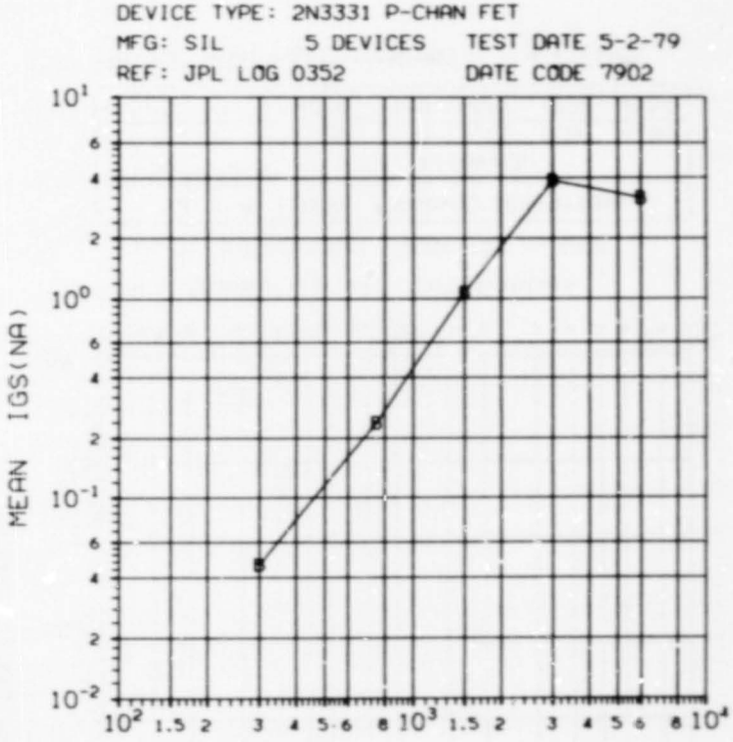
INITIAL MEAN VALUE IDSS(MA) = $9.67 \times 10^{+0}$



(1) VP; VDS=-15V, ID=10UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
A	.4722	.4722	.4722	.4722	.4722

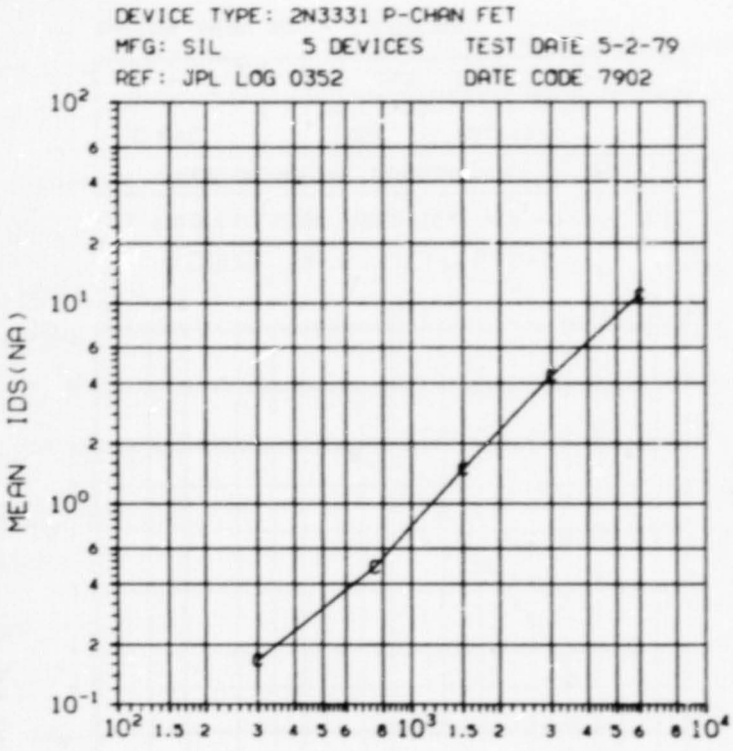
INITIAL MEAN VALUE VP(V) = 5.68×10^{0}



(2) IGS; VDS=0, VGS=+15V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
B	.0226	.3081	1.278	3.257	6.616

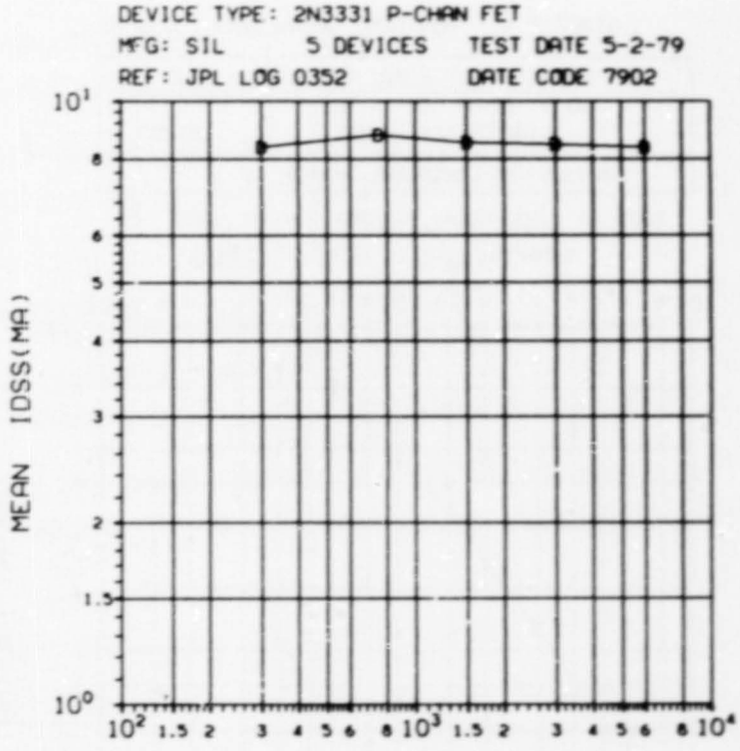
INITIAL MEAN VALUE IGS(NA) = 1.39×10^{-1}



(3) IDS; VDS=-15V, VGS=+15V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
C	.0452	.3512	1.432	3.750	6.435

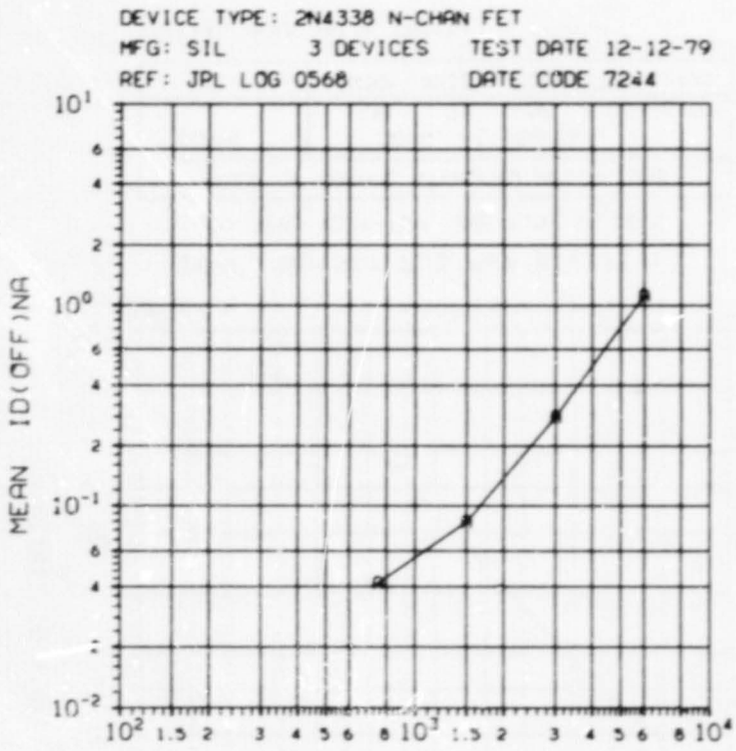
INITIAL MEAN VALUE IDS(NA) = 1.0×10^{-2}



(4) IDSS; VDS=-15V, VGS=0 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
D	.5796	.6496	.6419	.7127	.7060

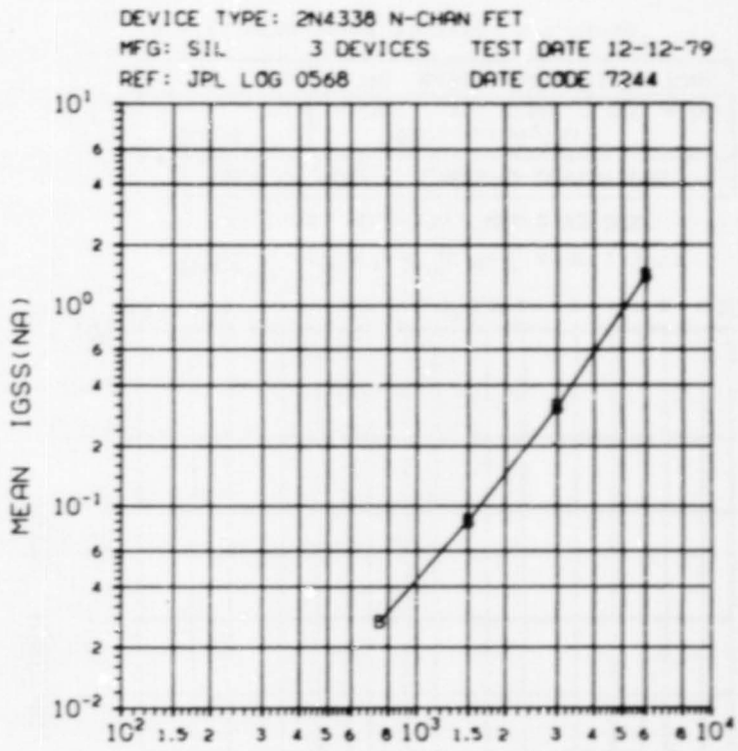
INITIAL MEAN VALUE IDSS(MA) = 8.34×10^{0}



(1) ID(OFF) IN NA; VDS=+12V, VGS=-5V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0038	.0187	.0954	.5188

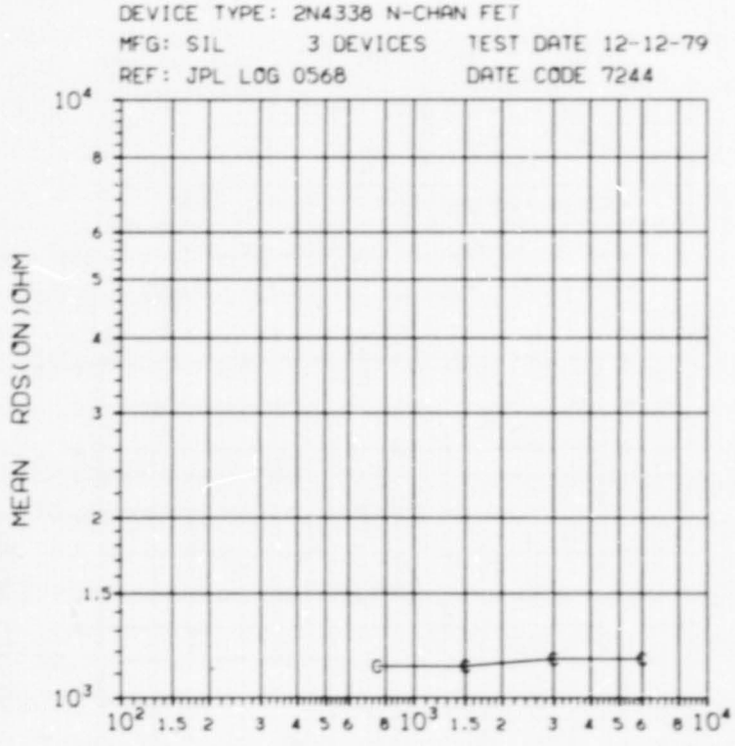
INITIAL MEAN VALUE ID(OFF)NA = 5.73×10^{-2}



(2) IGSS IN NA; VDS=0V, VGS=-12V: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	.0045	.0277	.1266	.6886

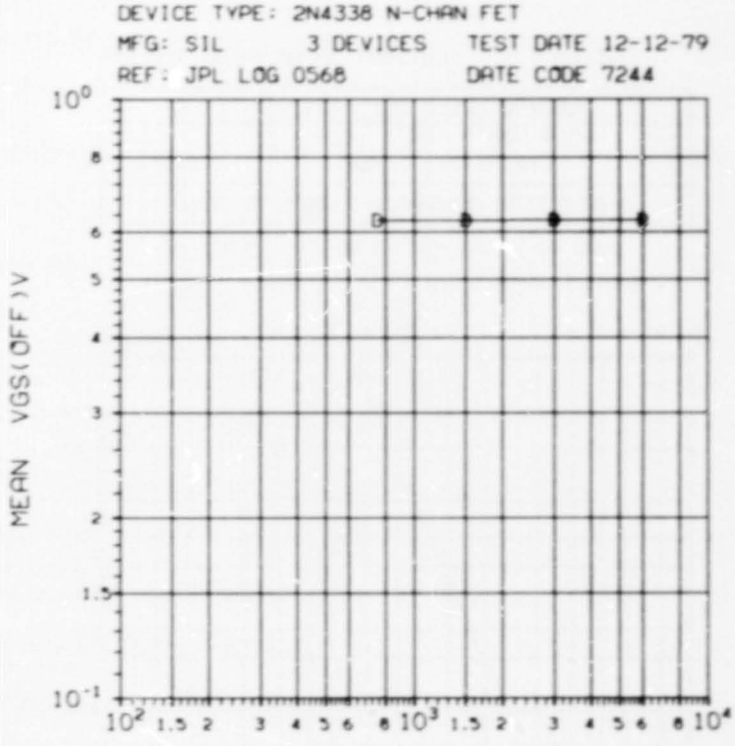
INITIAL MEAN VALUE IGSS(NA) = 3.33×10^{-2}



(3) RDS(ON) IN OHMS; VGS=0V, ID=10UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
C	152.8	152.8	208.2	208.2

INITIAL MEAN VALUE RDS(ON)OHM = $1.13 \times 10^{+3}$

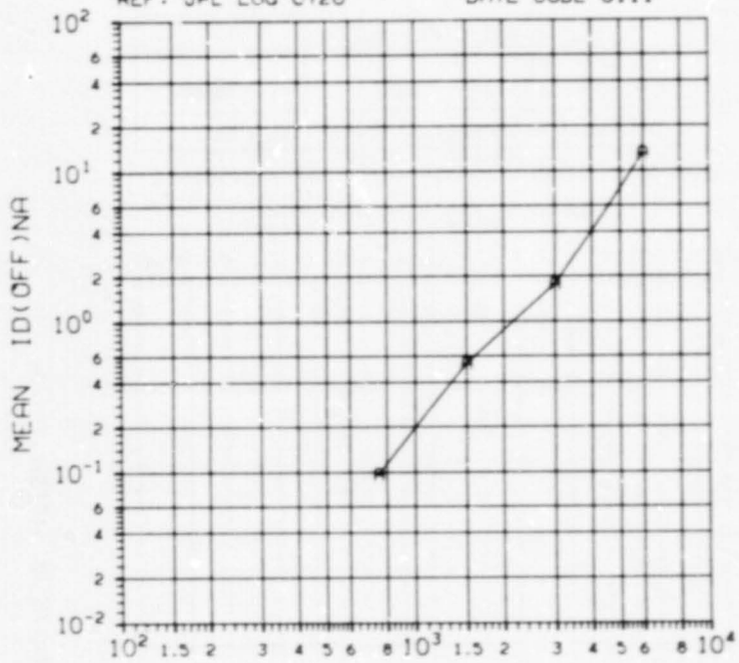


(4) VGS(OFF) IN VOLTS; VDS=+12V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
D	.1058	.1058	.1058	.1058

INITIAL MEAN VALUE VGS(OFF)V = 6.31×10^{-1}

DEVICE TYPE: 2N4338 N CHAN FET
MFG: CTI 8 DEVICES TEST DATE 4-10-81
REF: JPL LOG 0726 DATE CODE 8111

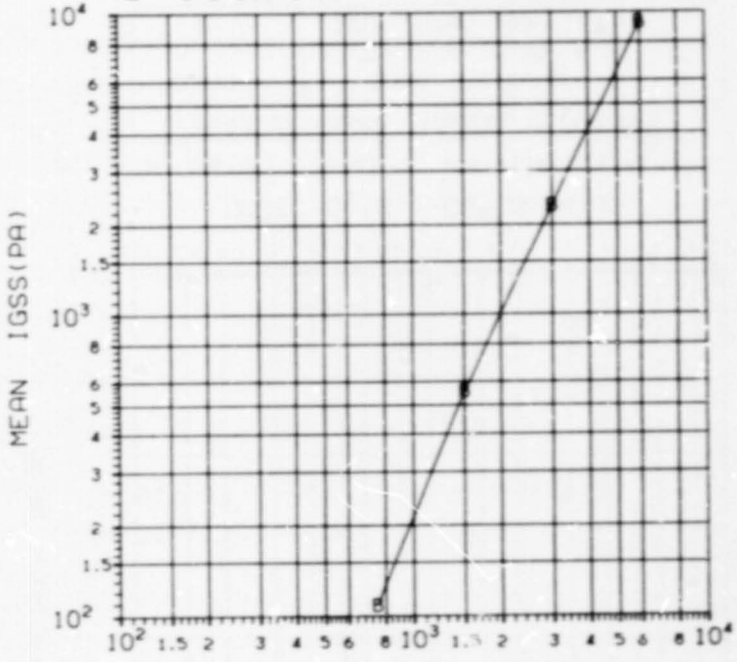


(1)ID(OFF)NA;VDS=12V,VGS=-5V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
A	.0284	.1168	.4567	4.913

INITIAL MEAN VALUE ID(OFF)NA = 4.57×10^{-2}

DEVICE TYPE: 2N4338 N CHAN FET
MFG: CTI 8 DEVICES TEST DATE 4-10-81
REF: JPL LOG 0726 DATE CODE 8111

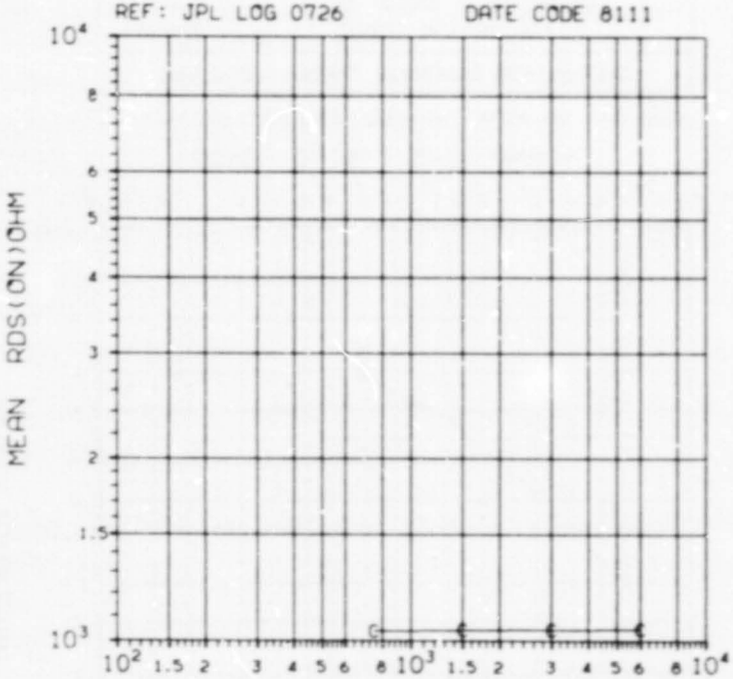


(2)IGSS(PA);VDS=0V,VGS=-12V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00	6.00
B	21.23	120.0	537.8	2785.

INITIAL MEAN VALUE IGSS(PA) = 5.99×10^{0}

DEVICE TYPE: 2N4338 N CHAN FET
MFG: CTI 8 DEVICES TEST DATE 4-10-81
REF: JPL LOG 0726 DATE CODE 8111



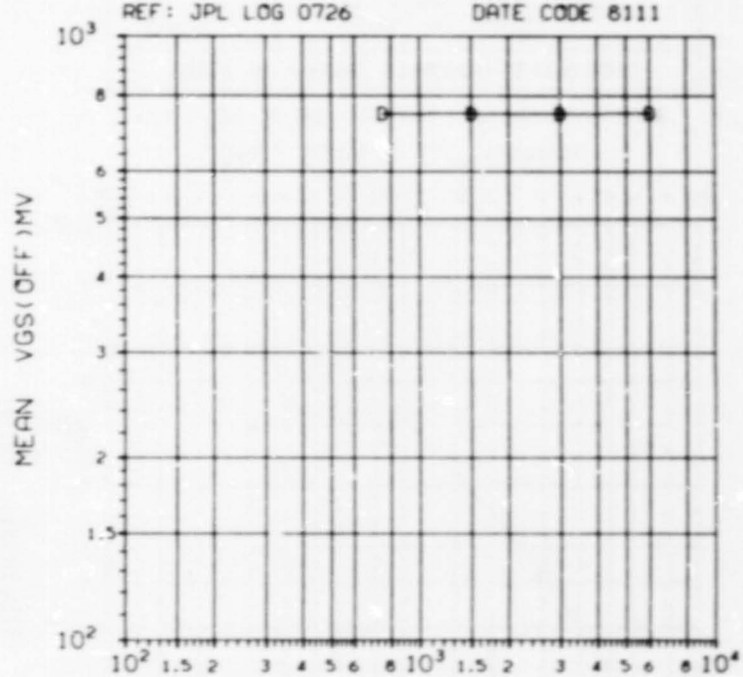
DOSE, Gy(Si) 2.5 MeV electrons

(3)RDS(ON)OHM;VGS=0V,ID=10UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
C	50.91	50.99	51.35	50.43

INITIAL MEAN VALUE RDS(ON)OHM = $9.81 \times 10^{+2}$

DEVICE TYPE: 2N4338 N CHAN FET
MFG: CTI 8 DEVICES TEST DATE 4-10-81
REF: JPL LOG 0726 DATE CODE 8111

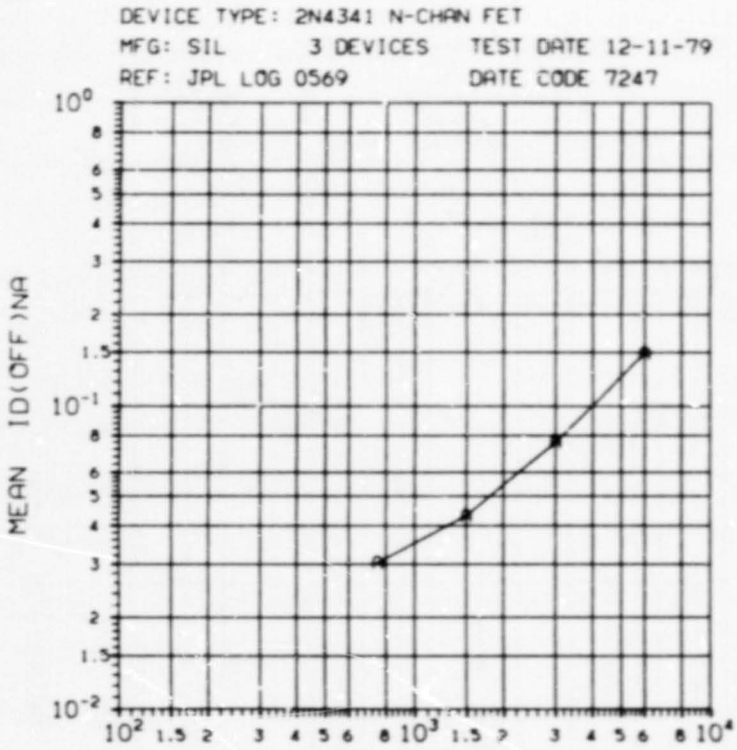


DOSE, Gy(Si) 2.5 MeV electrons

(4)VGS(OFF)MV;VDS=12V,ID=0.1UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
D	60.59	59.95	60.11	60.26

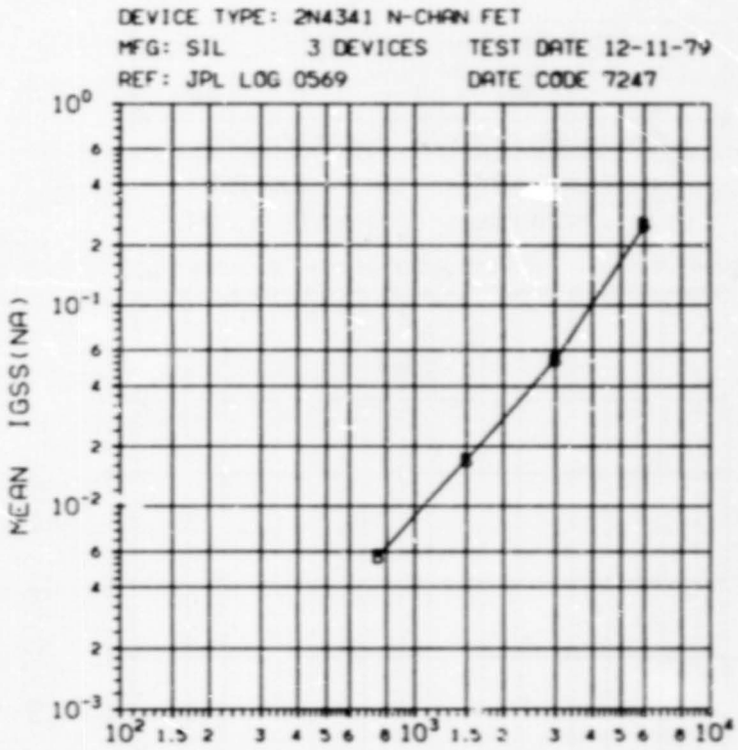
INITIAL MEAN VALUE VGS(OFF)MV = $7.51 \times 10^{+2}$



(1) ID(OFF) IN NA; VDS=+6V, VGS=-6V vs DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0061	.0044	.0294	.0301

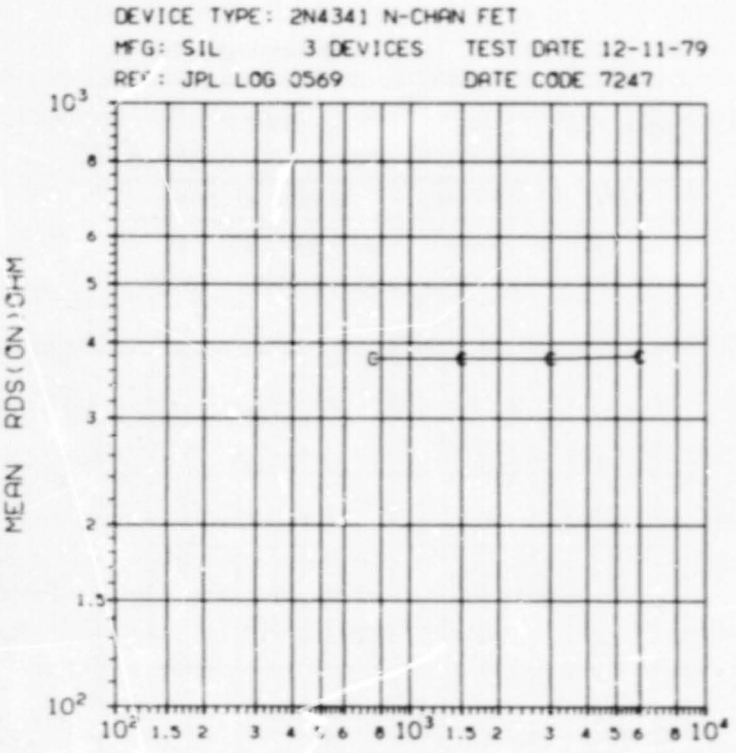
INITIAL MEAN VALUE ID(OFF)NA = 3.63×10^{-2}



(2) IGSS IN NA; VDS=0V, VGS=-6V vs DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	.0025	.0072	.0401	.2003

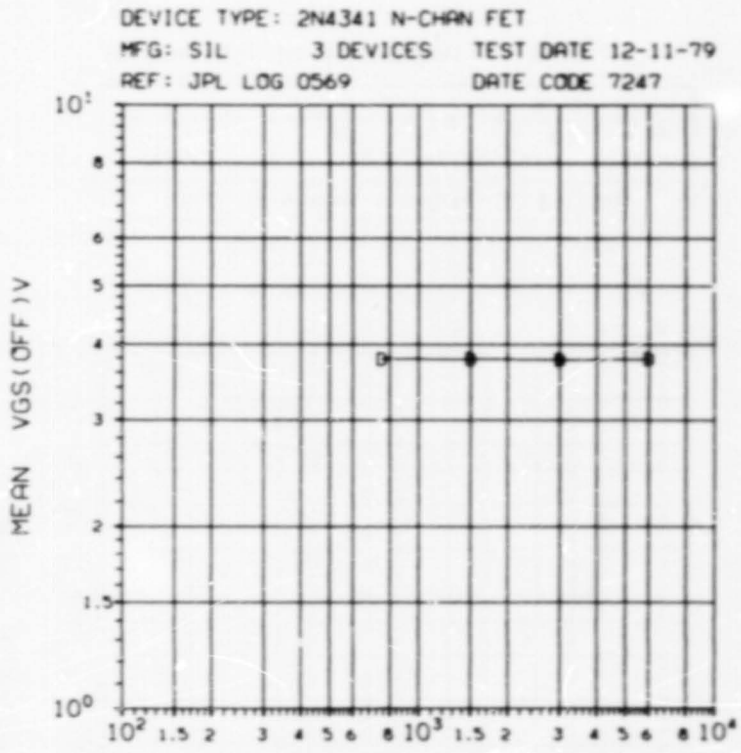
INITIAL MEAN VALUE IGSS(NA) = 1.07×10^{-2}



(3) RDS(ON) IN OHMS; VGS=0V, ID=100U VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
C	5.774	5.774	5.774	

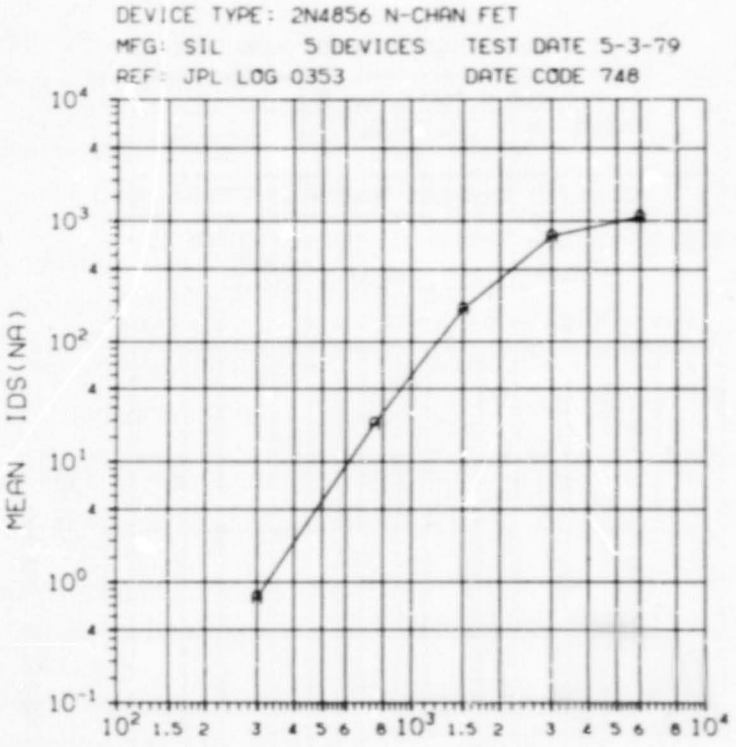
INITIAL MEAN VALUE RDS(ON)OHM = $3.77 \times 10^{+2}$



(4) VGS(OFF) IN VOLTS; VDS=+6V, ID=0 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
D	.4107	.4103	.4041	.4098

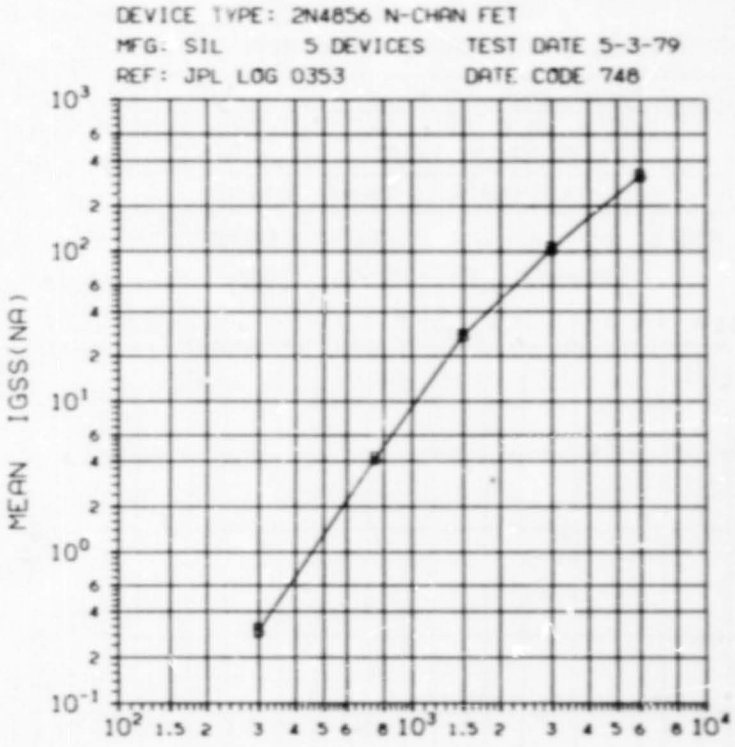
INITIAL MEAN VALUE VGS(OFF)V = 3.79×10^{0}



(1) IDS; VGS=-30V, VDS=15V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, krIoGy(Si)				
	.30	.75	1.50	3.00	6.00
A	.2672	6.035	36.74	202.2	1138.

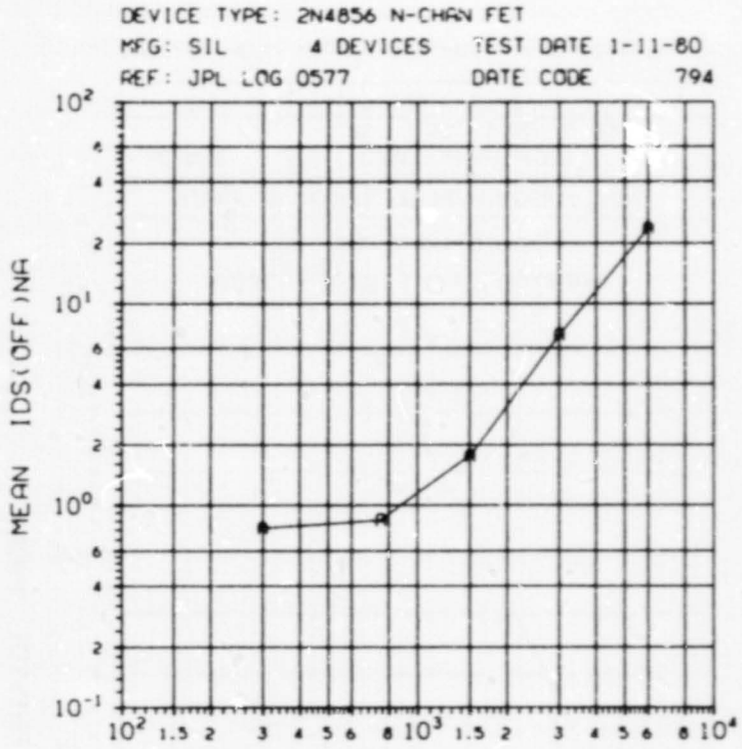
INITIAL MEAN VALUE IDS(NA) = 8.14×10^{-2}



(2) IGSS; VGS=-30V, VDS=0 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, krIoGy(Si)				
	.30	.75	1.50	3.00	6.00
B	.1040	.5958	2.679	32.21	152.4

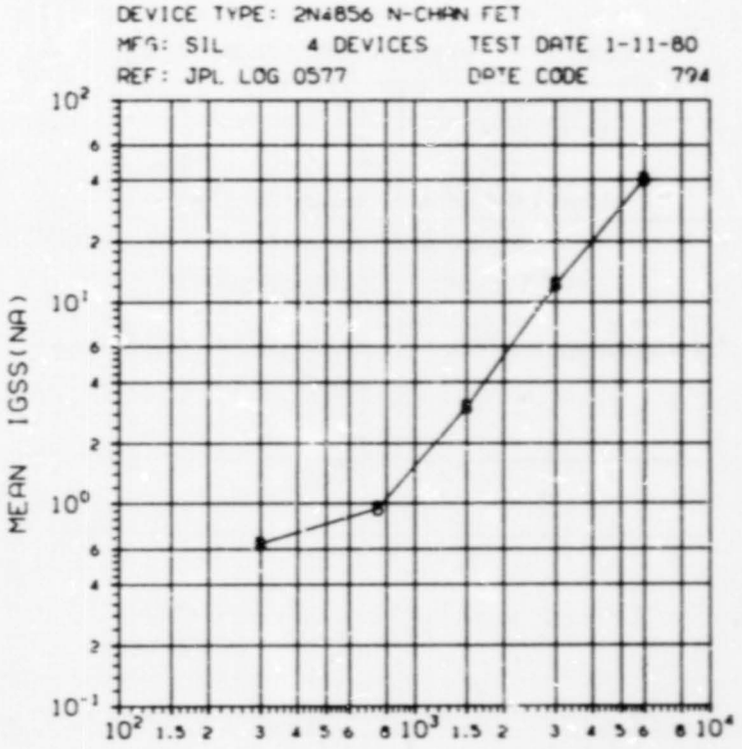
INITIAL MEAN VALUE IGSS(NA) = 5.38×10^{-2}



(1) IDS(OFF) IN NA; VGS=-30V, VDS=15 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
A	.2170	.5775	2.564	13.36	46.24

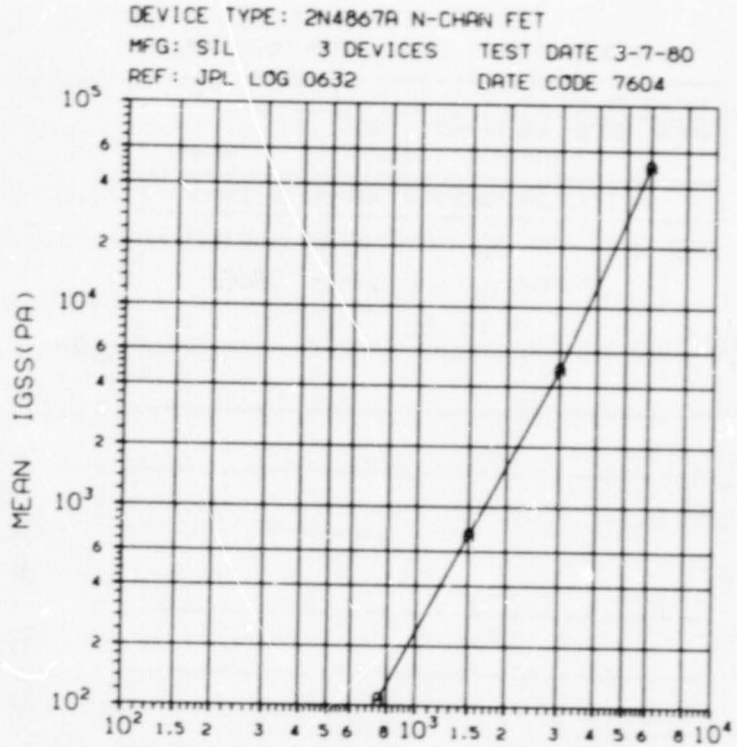
INITIAL MEAN VALUE IDS(OFF)NA = 4.70×10^{-1}



(2) IGSS IN NA; VGS=-30V, VDS=0 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
B	.2228	.4219	1.851	8.252	27.25

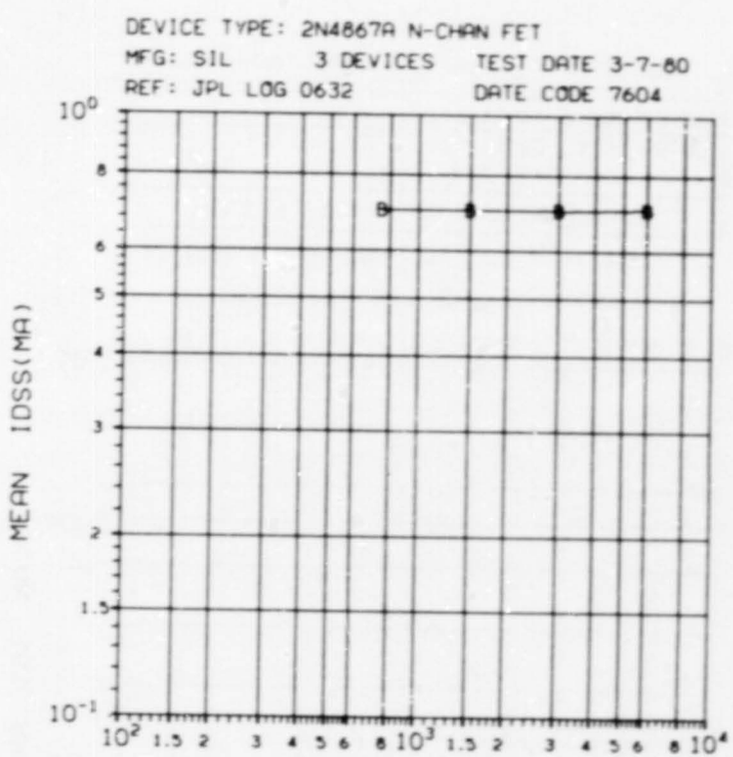
INITIAL MEAN VALUE IGSS(NA) = 3.15×10^{-1}



(1) IGSS IN PA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	13.11	195.0	1747.	

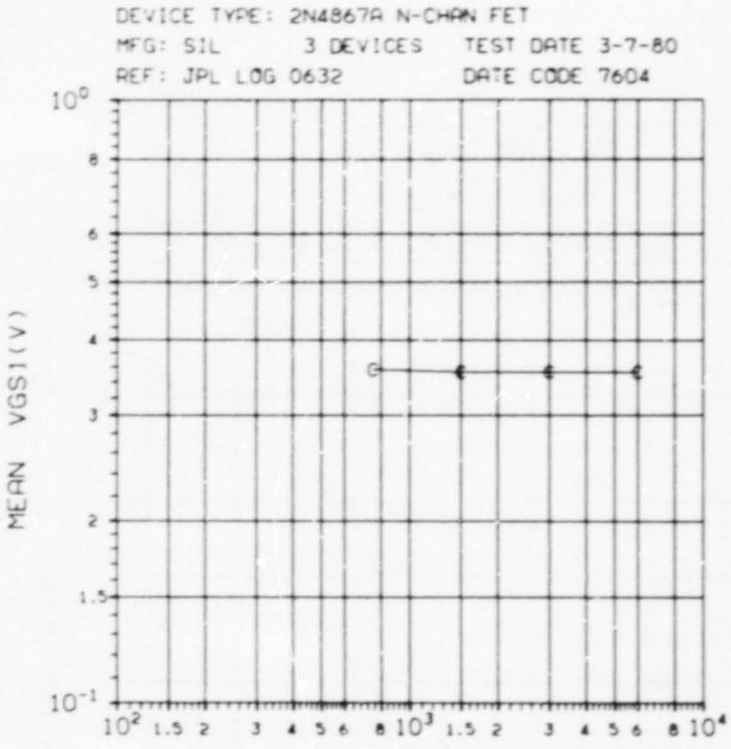
INITIAL MEAN VALUE IGSS(PA) = $2.47 \times 10^{+1}$



(2) IDSS IN MA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	.2364	.2364	.2364	.2375

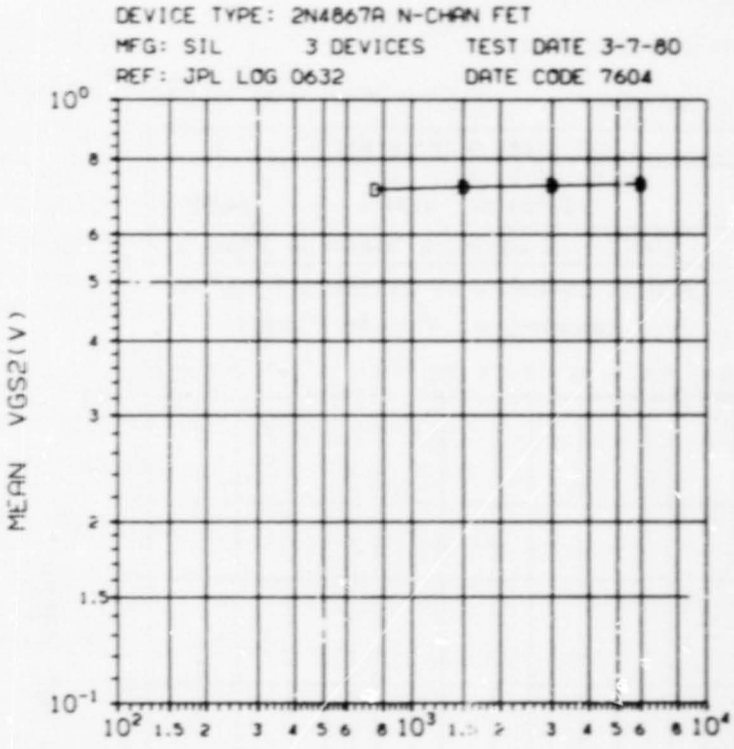
INITIAL MEAN VALUE IDSS(MA) = 7.07×10^{-1}



(3A) VGS1 IN VOLTS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
C	.1779	.1721	.1721	.1721

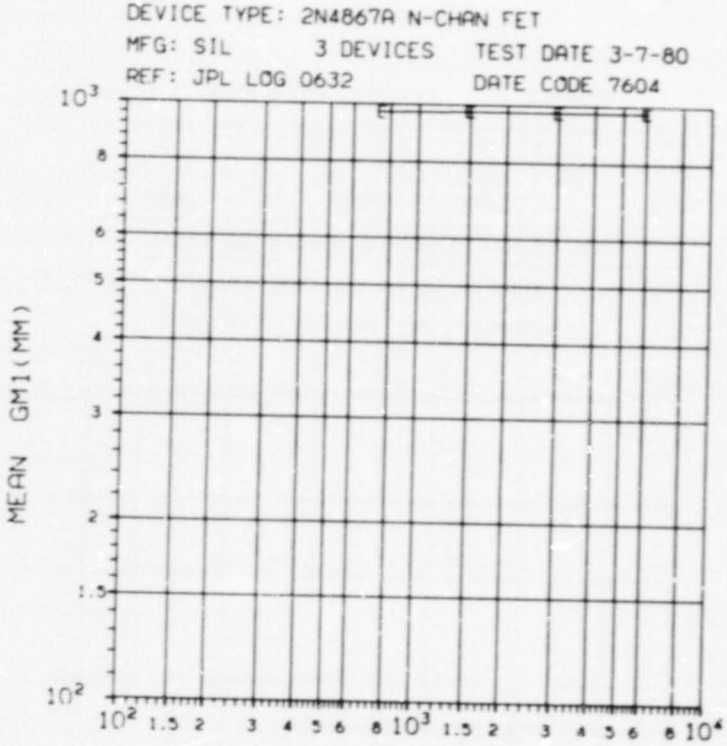
INITIAL MEAN VALUE VGS1(V) = 3.53×10^{-1}



(3B) VGS2 IN VOLTS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
D	.0208	.0173	.0208	.0231

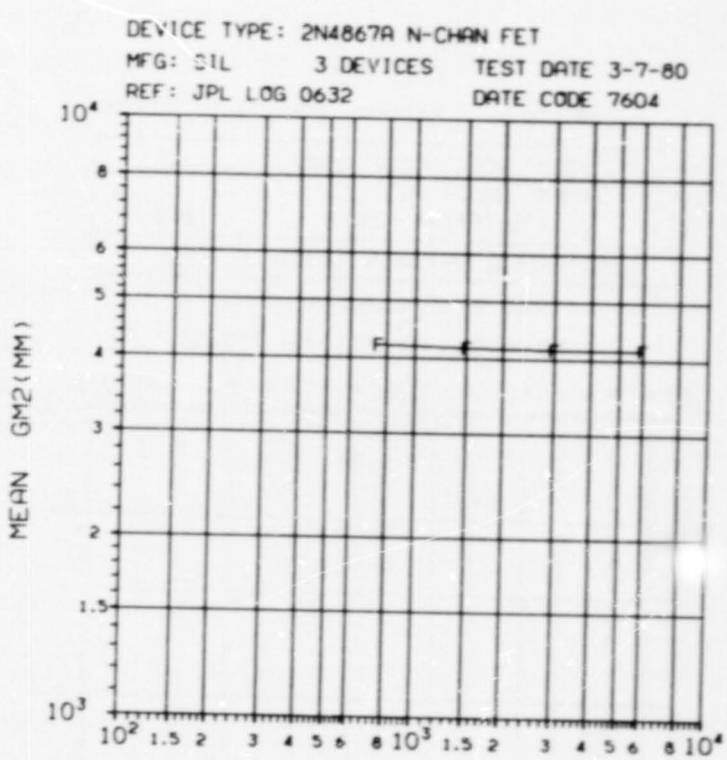
INITIAL MEAN VALUE VGS2(V) = 7.10×10^{-1}



(4) GM1 (ID=300UA) IN MICROMHOS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
E	393.9	388.5	388.5	388.5

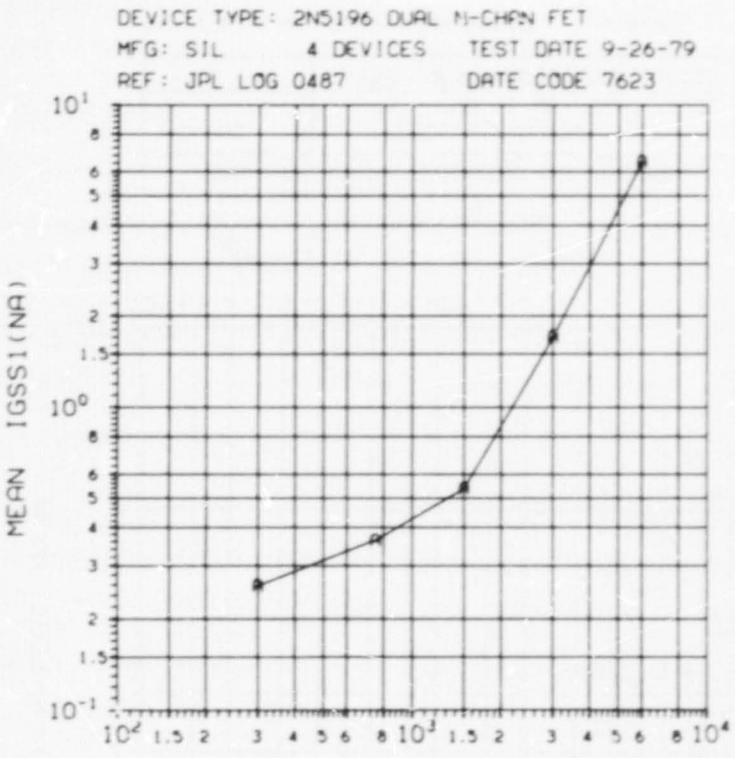
INITIAL MEAN VALUE GM1(MM) = $9.73 \times 10^{+2}$



(5) GM2 (ID=3000UA) IN MICROMHOS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
F	124.3	101.6	121.1	121.1

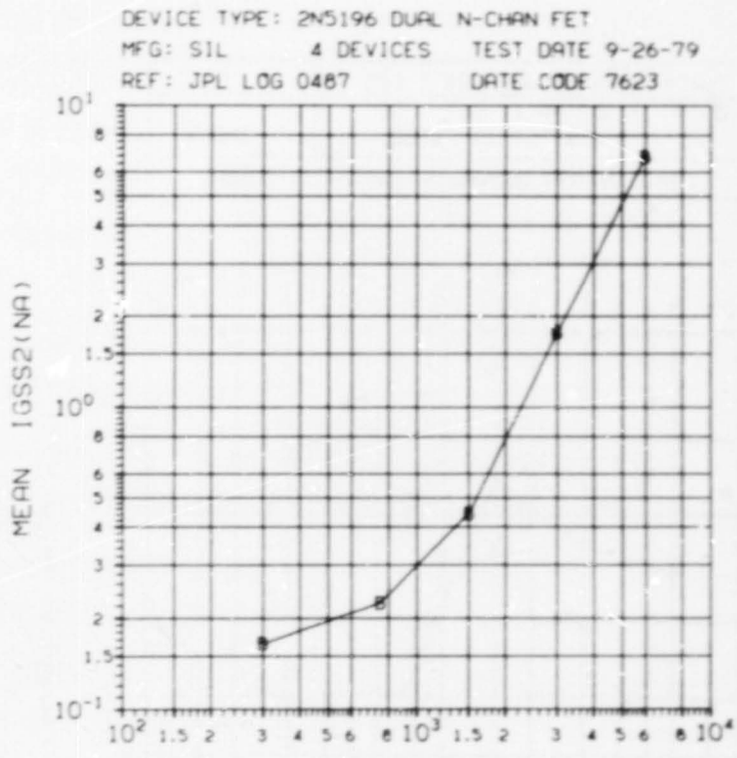
INITIAL MEAN VALUE GM2(MM) = $4.23 \times 10^{+3}$



(1) IGSS1 IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
A	.0789	.0714	.0608	.3651	2.061

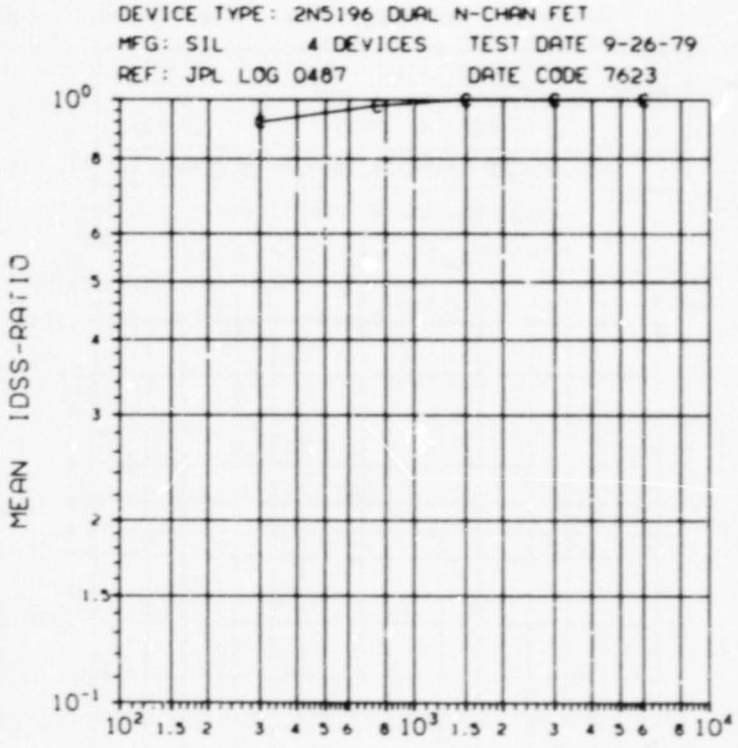
INITIAL MEAN VALUE IGSS1(NA) = 2.22×10^{0}



(2) IGSS2 IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
B	.1289	.1621	.1739	.4535	1.475

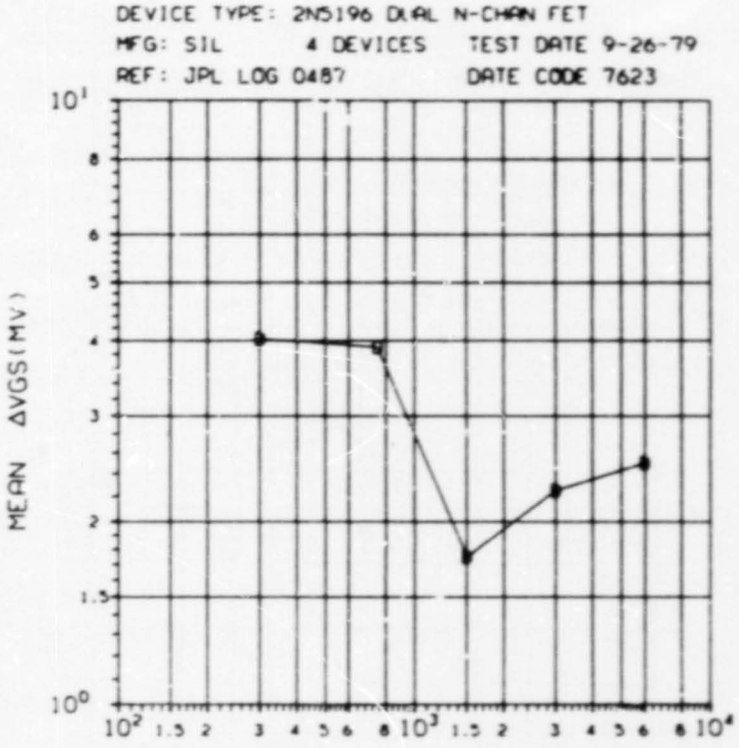
INITIAL MEAN VALUE IGSS2(NA) = 1.60×10^{0}



(3) IDSS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
C	.1452	.0435	.0000	.0000	.0000

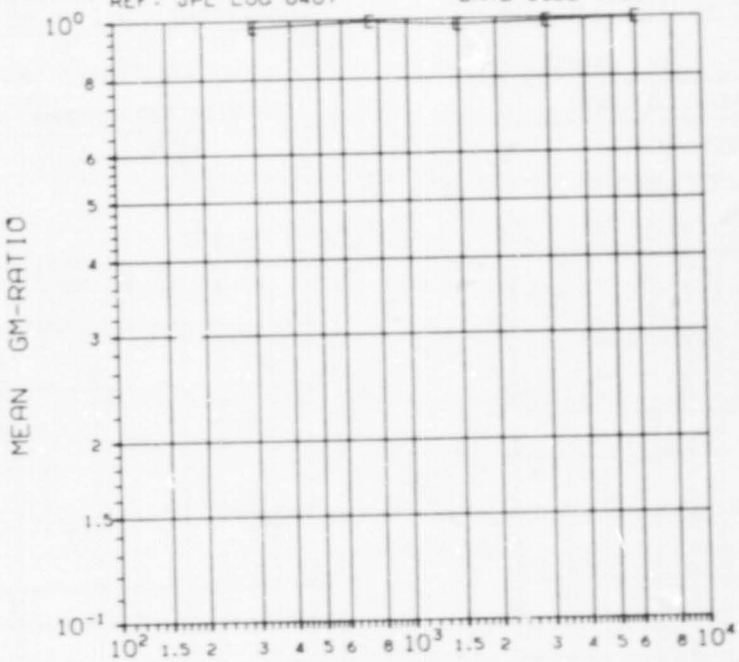
INITIAL MEAN VALUE IDSS-RATIO = 9.95×10^{-1}



(4) ΔVGS (VGS-VGS2) IN MV VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
D	3.023	1.685	.5000	.9574	1.291

DEVICE TYPE: 2N5196 DUAL N-CHAN FET
MFG: SIL 4 DEVICES TEST DATE 9-26-79
REF: JPL LOG 0487 DATE CODE 7623

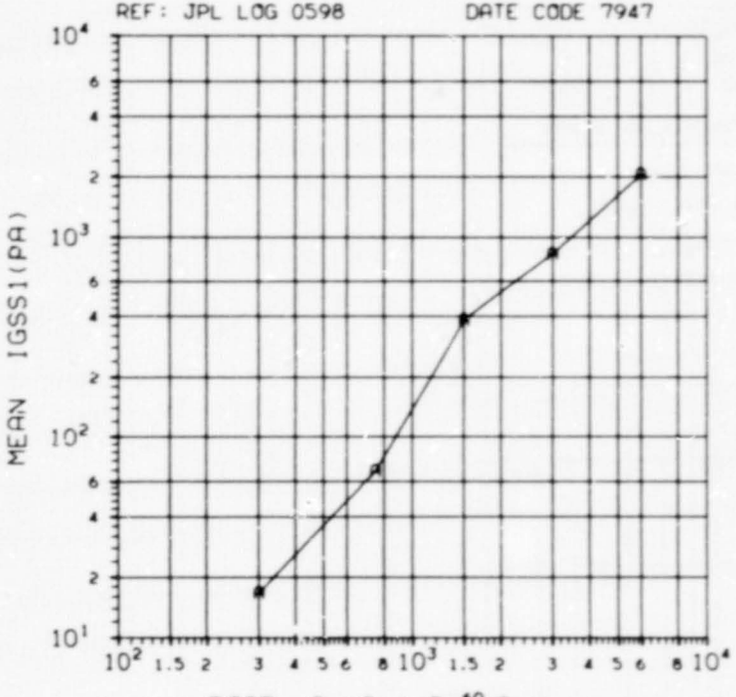


(5) GM1/GM2 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
E	.0170	.0068	.0081	.0109	.0020

INITIAL MEAN VALUE GM-RATIO = 9.84×10^{-1}

DEVICE TYPE: 2N5196 DUAL N-CHAN FET
MFG: SIL 5 DEVICES TEST DATE 2-22-80
REF: JPL LOG 0598 DATE CODE 7947

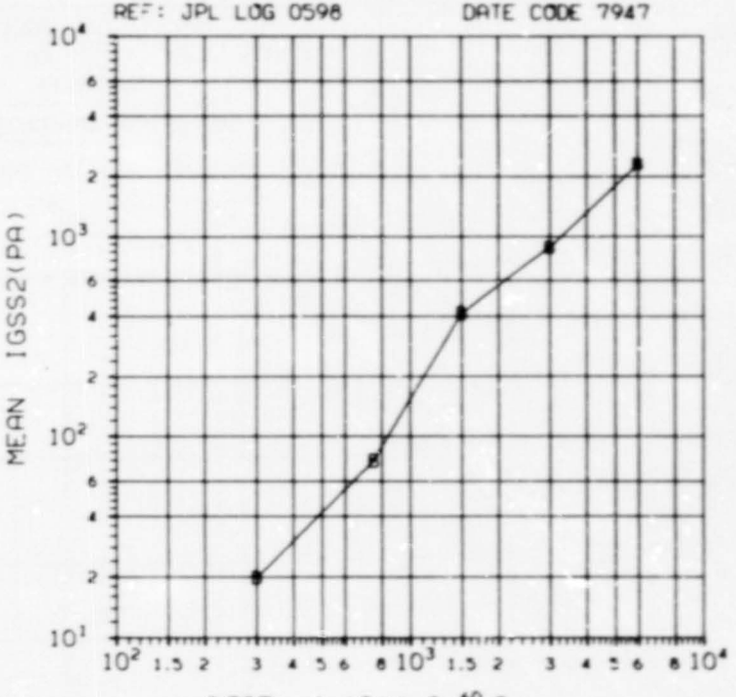


(1A) IGSS1 IN PA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
A	13.54	36.56	174.6	353.2	862.0

INITIAL MEAN VALUE IGSS1(PA) = $2.47 \times 10^{+1}$

DEVICE TYPE: 2N5196 DUAL N-CHAN FET
MFG: SIL 5 DEVICES TEST DATE 2-22-80
REF: JPL LOG 0598 DATE CODE 7947

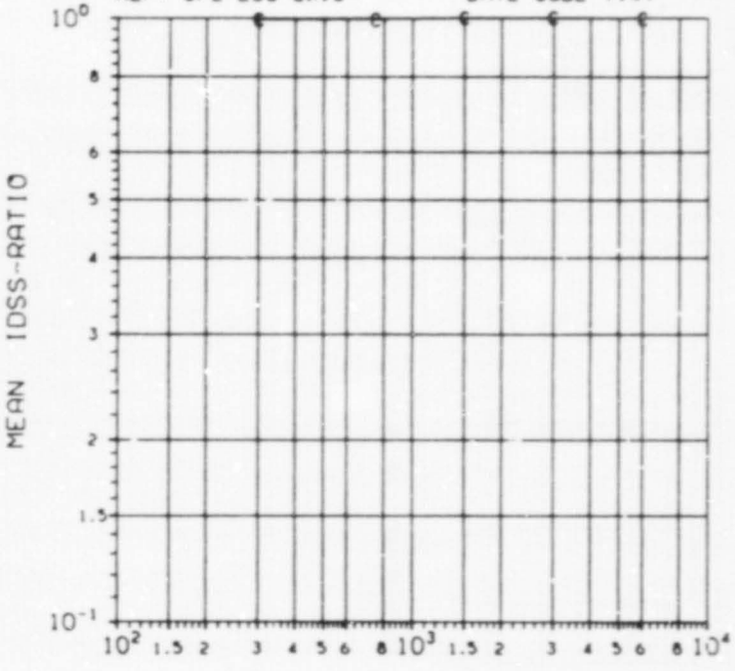


(1B) IGSS2 IN PA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
B	23.11	36.34	65.80	159.4	430.1

INITIAL MEAN VALUE IGSS2(PA) = $2.63 \times 10^{+1}$

DEVICE TYPE: 2N5196 DUAL N-CHAN FET
MFG: SIL 5 DEVICES TEST DATE 2-22-80
REF: JPL LOG 0598 DATE CODE 7947

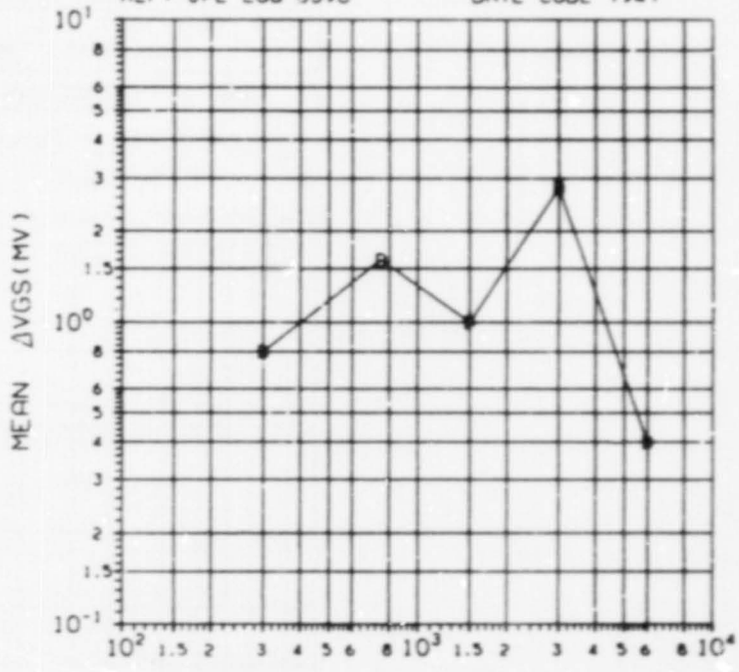


(2) IDSS1/IDSS2 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
C	.0074	.0074	.0000	.0000	.0061

INITIAL MEAN VALUE IDSS-RATIO = 9.93×10^{-1}

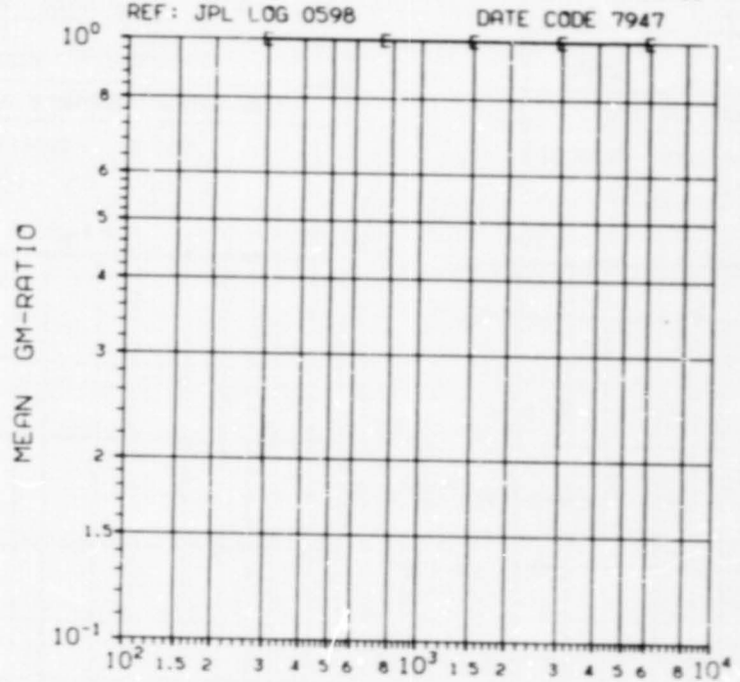
DEVICE TYPE: 2N5196 DUAL N-CHAN FET
MFG: SIL 5 DEVICES TEST DATE 2-22-80
REF: JPL LOG 0598 DATE CODE 7947



(3) ΔVGS (VGS1-VGS2) IN MV; ID=300UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
D	.4472	.8944	1.225	2.387	.5477

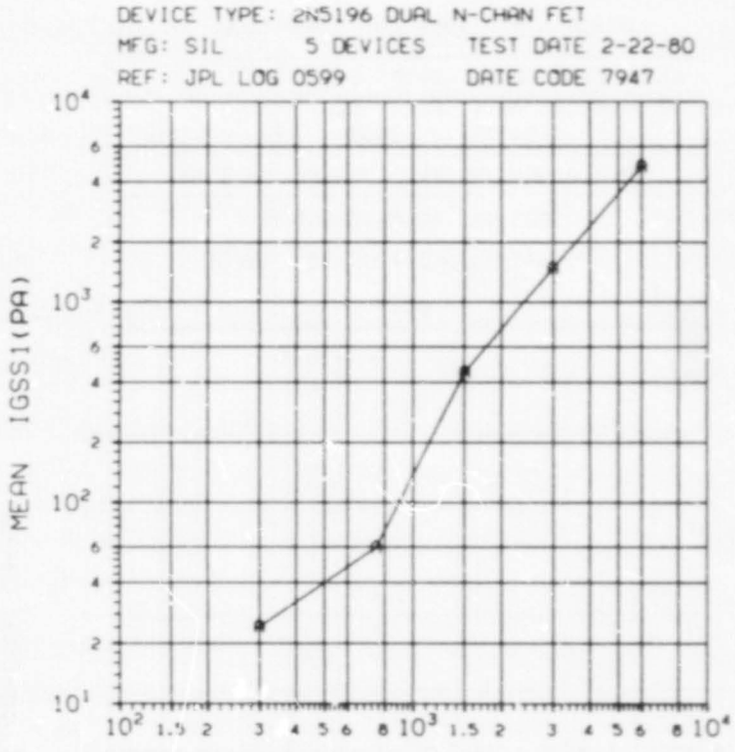
DEVICE TYPE: 2N5196 DUAL N-CHAN FET
MFG: SIL 5 DEVICES TEST DATE 2-22-80
REF: JPL LOG 0598 DATE CODE 7947



(4) GM1/GM2; ID=300UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
E	.0004	.0004	.0007	.0011	.0005

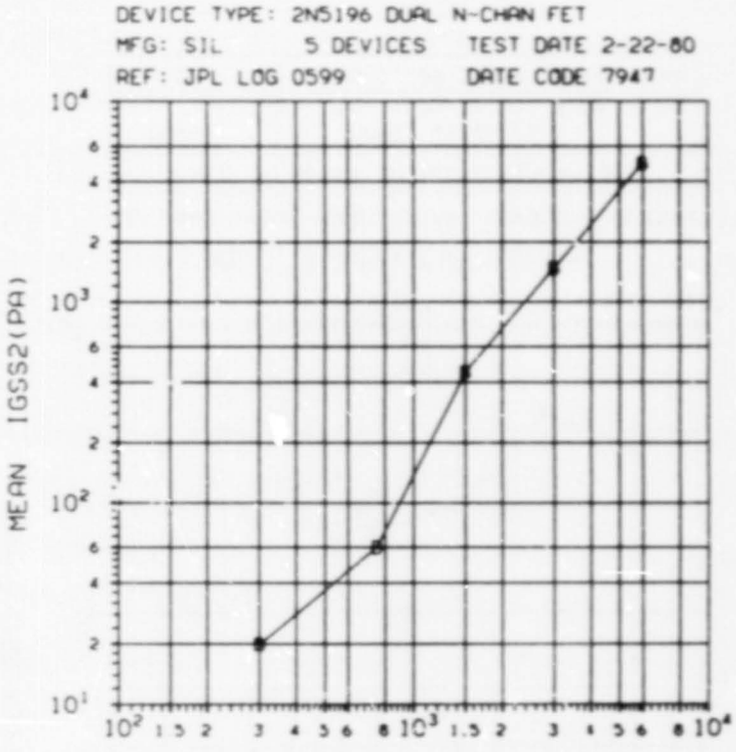
INITIAL MEAN VALUE GM-RATIO = 9.99×10^{-1}



(1A) IGSS1 IN PA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
A	16.08	20.44	59.33	171.8	589.1

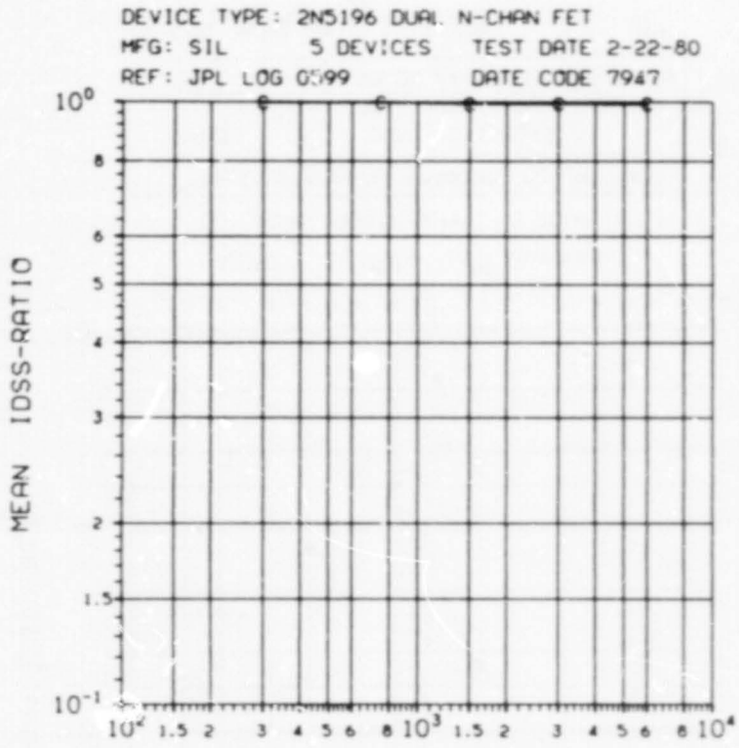
INITIAL MEAN VALUE IGSS1(PA) = $1.03 \times 10^{+1}$



(1B) IGSS2 IN PA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
B	12.46	10.11	40.25	115.1	465.8

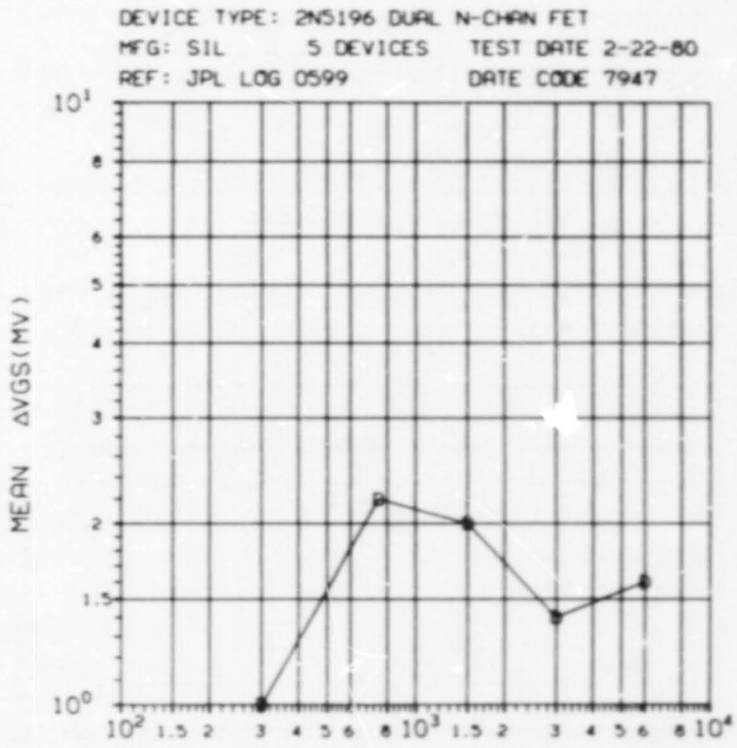
INITIAL MEAN VALUE IGSS2(PA) = 8.10×10^{0}



(2) IDSS1/IDSS2 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
C	.0046	.0046	.0070	.0070	.0079

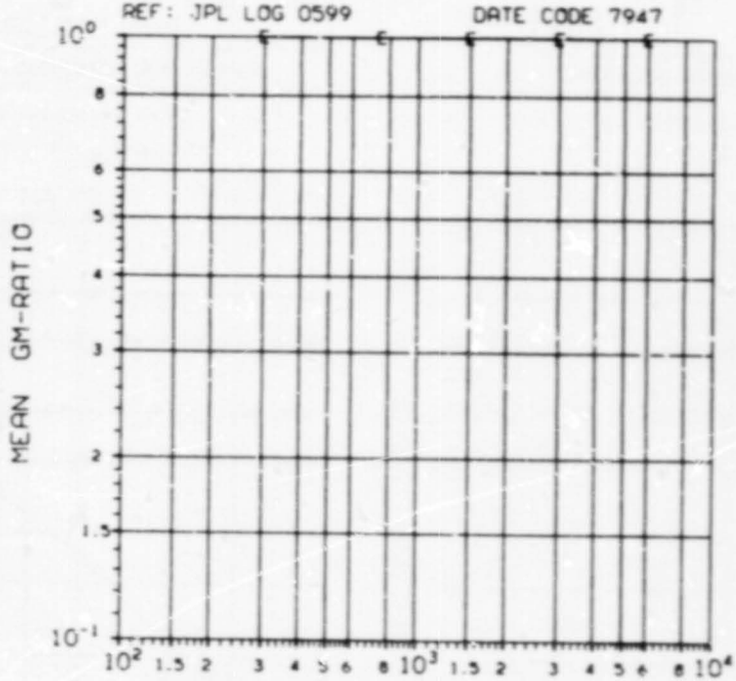
INITIAL MEAN VALUE IDSS-RATIO = 9.95×10^{-1}



(3) ΔVGS (VGS1-VGS2) IN MV; ID=300UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
D	1.000	1.789	1.871	.8944	.8944

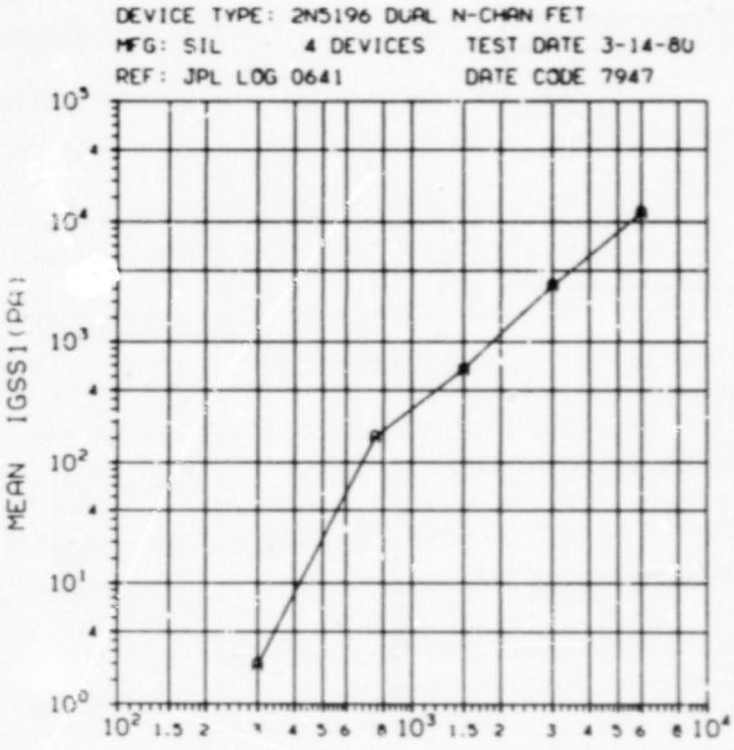
DEVICE TYPE: 2N5196 DUAL N-CHAN FET
MFG: SIL 5 DEVICES TEST DATE 2-22-80
REF: JPL LOG 0599 DATE CODE 7947



(4) GM1/GM2; ID=300UA vs DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, $\times 10^2$ Gy(Si)				
	.30	.75	1.50	3.00	6.00
E	.0006	.0011	.0010	.0006	.0007

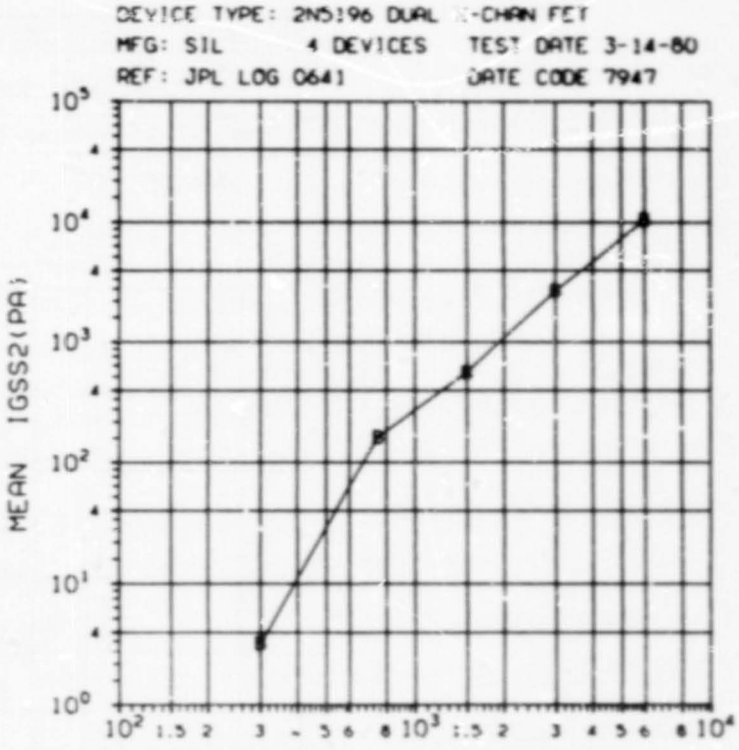
INITIAL MEAN VALUE GM-RATIO = 9.99×10^{-1}



(1A) IGSS1 IN PA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
A	2.016	10.31	80.16	464.6	2394.

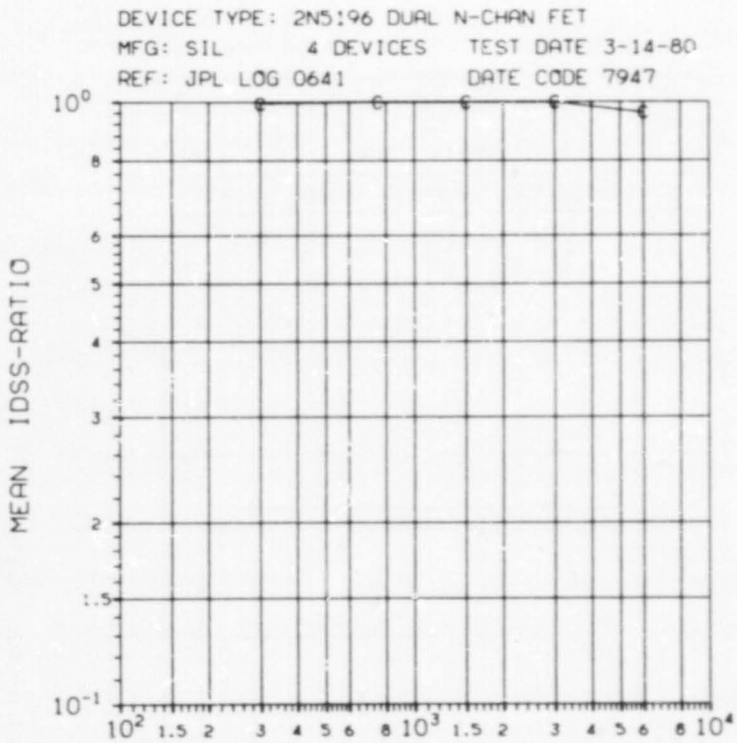
INITIAL MEAN VALUE IGSS1(PA) = 9.35x10 ^{0}



(1B) IGSS2 IN PA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
B	1.500	7.500	40.29	263.0	1229.

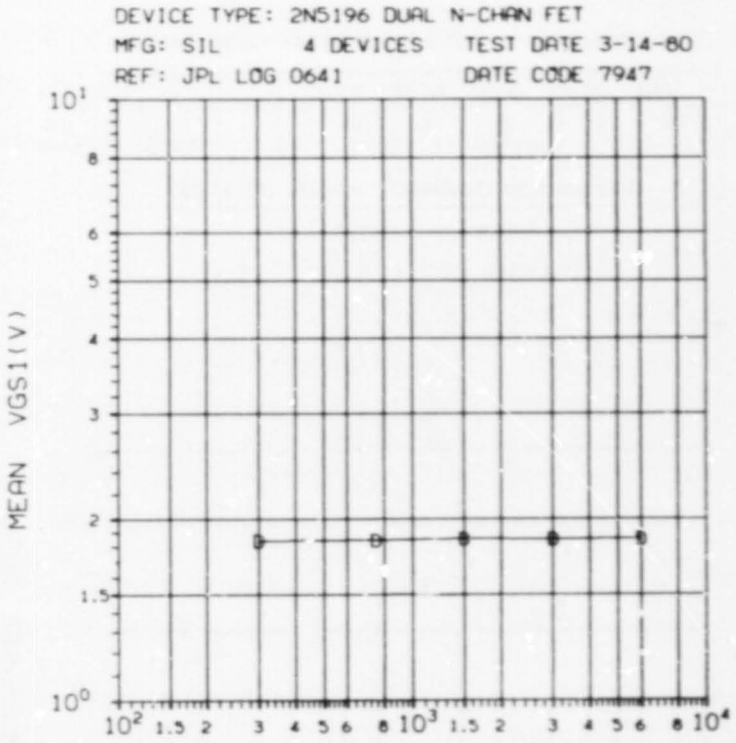
INITIAL MEAN VALUE IGSS2(PA) = 8.62x10 ^{0}



(2) IDSS1/IDSS2 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
C	.0129	.0000	.0000	.0000	.0796

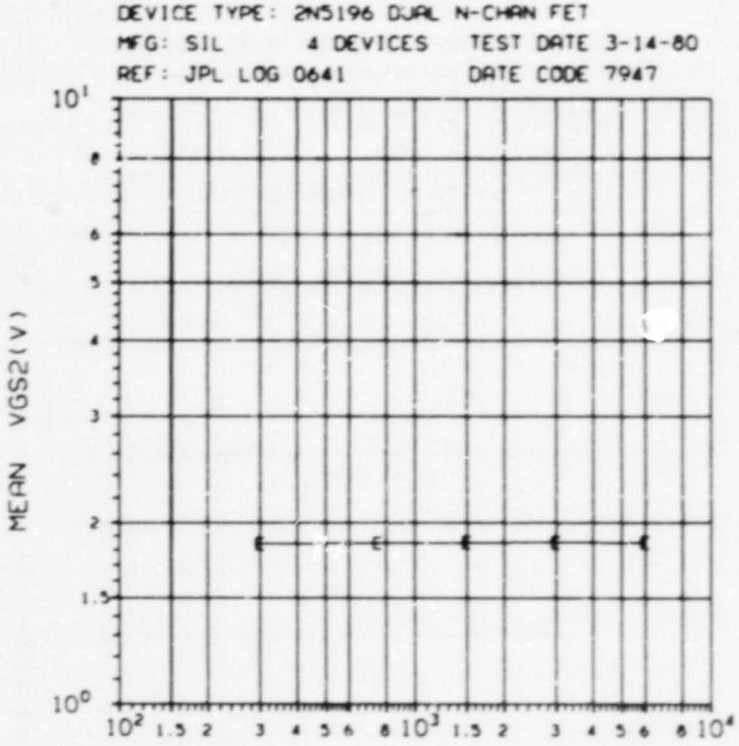
INITIAL MEAN VALUE IDSS-RATIO = 9.97×10^{-1}



(3A) VGS1 IN VOLTS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
D	.1611	.1688	.1601	.1647	.1601

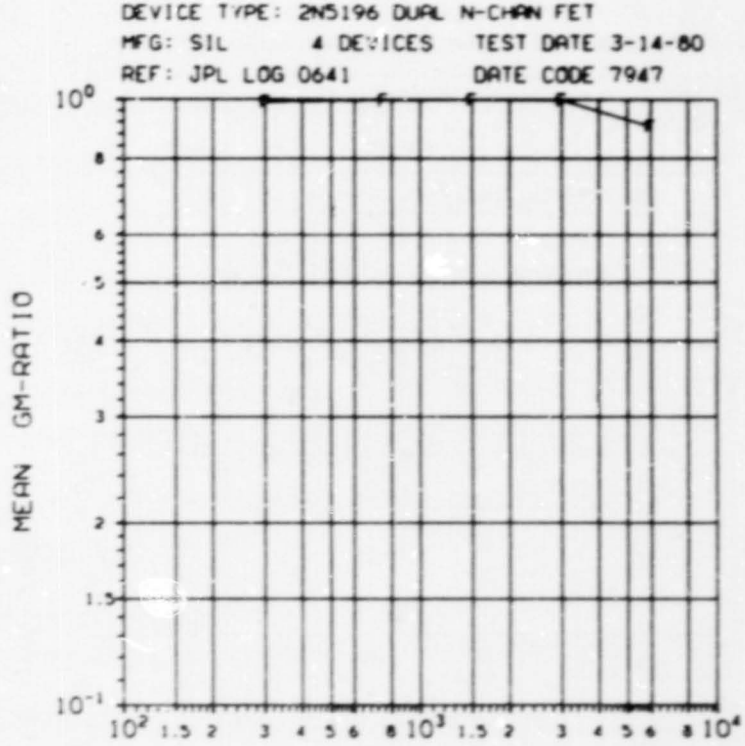
INITIAL MEAN VALUE VGS1(V) = 1.84×10^{0}



(3B) VGS2 IN VOLTS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
E	.1652	.1644	.1647	.1601	.1598

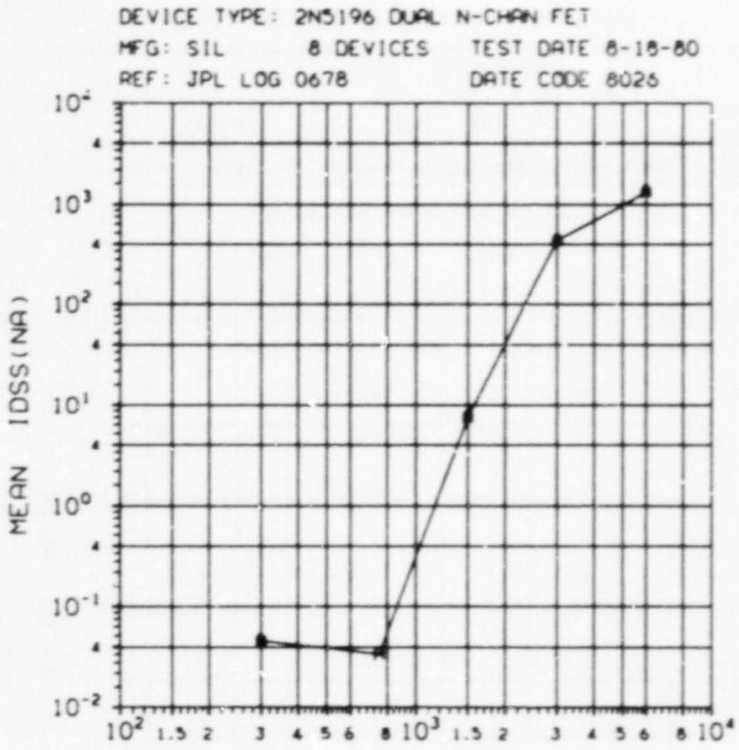
INITIAL MEAN VALUE VGS2(V) = 1.84×10^{0}



(4) GM1/GM2 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
F	.0118	.0035	.0030	.0030	.1920

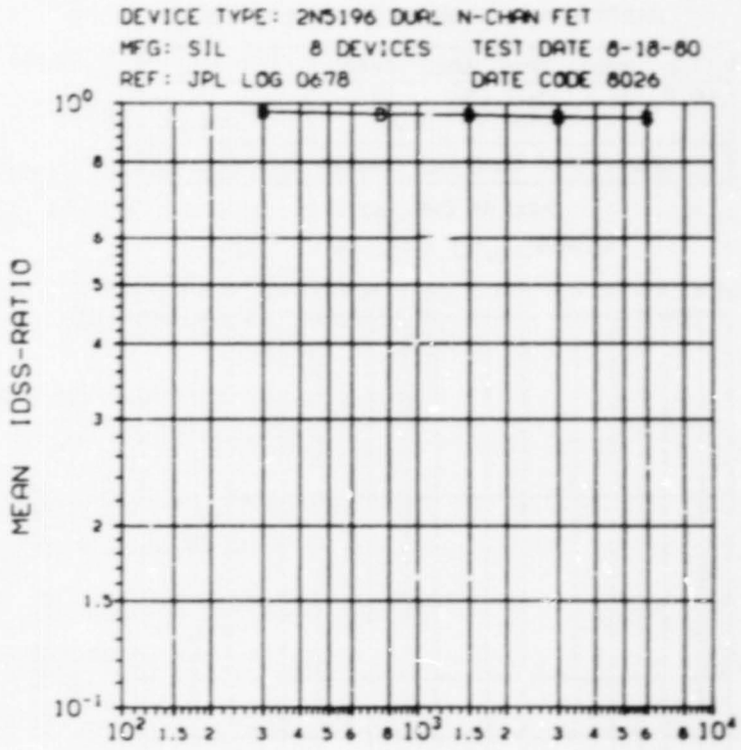
INITIAL MEAN VALUE GM-RATIO = 9.97×10^{-1}



(1) IGSS IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
A	.0302	.0288	2.516	105.5	71.04

INITIAL MEAN VALUE IDSS(NA) = 1.75×10^{-2}

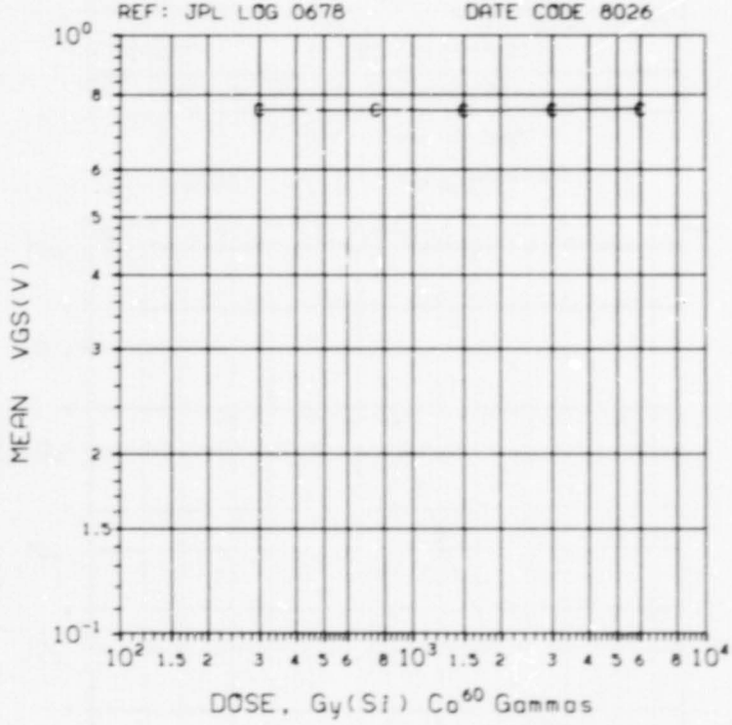


(2) IDSS1/IDSS2 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
B	.0654	.0813	.0766	.0953	.0997

INITIAL MEAN VALUE IDSS-RATIO = 9.52×10^{-1}

DEVICE TYPE: 2N5196 DUAL N-CHAN FET
MFG: SIL 8 DEVICES TEST DATE 8-18-80
REF: JPL LOG 0678 DATE CODE 8026

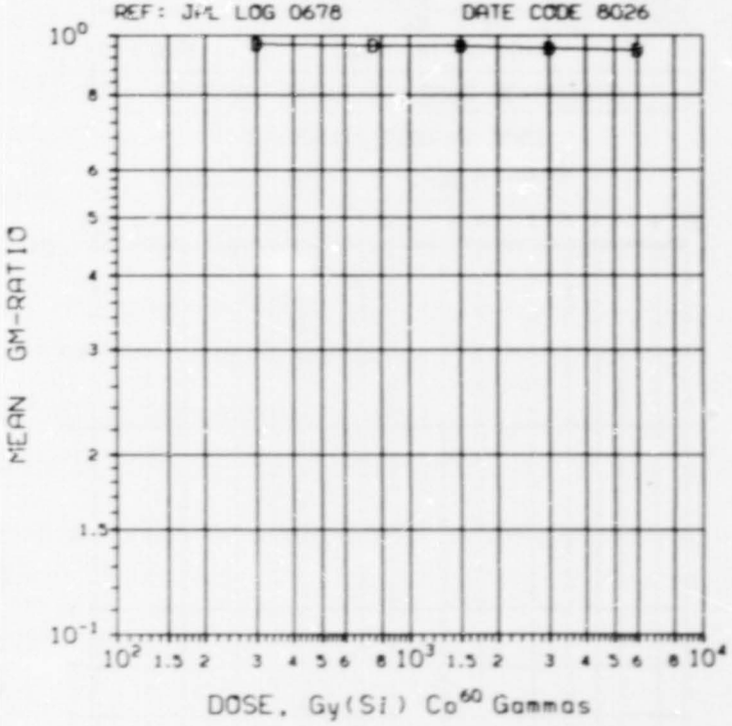


(3) VGS IN VOLTS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
C	.1933	.1935	.1942	.1956	.1953

INITIAL MEAN VALUE VGS(V) = 7.53×10^{-1}

DEVICE TYPE: 2N5196 DUAL N-CHAN FET
MFG: SIL 8 DEVICES TEST DATE 8-18-80
REF: JPL LOG 0678 DATE CODE 8026

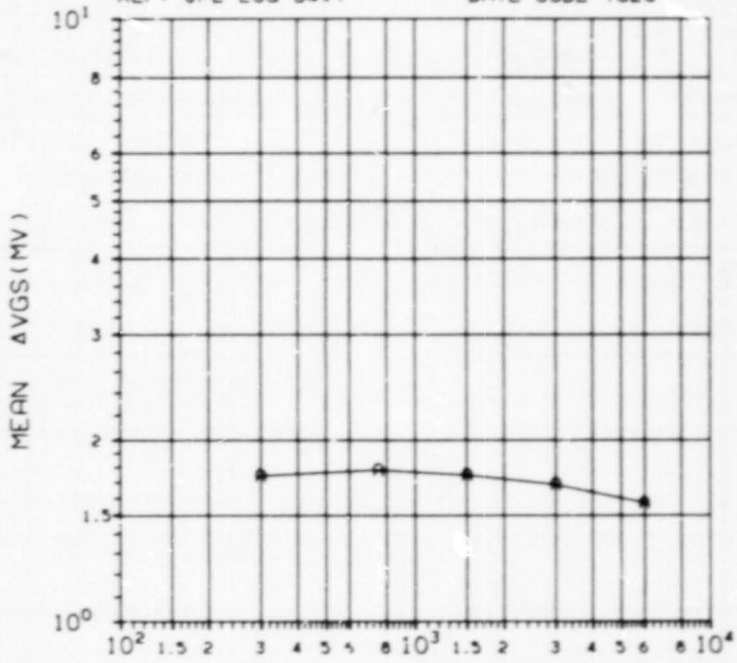


(4) GM1/GM2 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
D	.0591	.0789	.0666	.0888	.0911

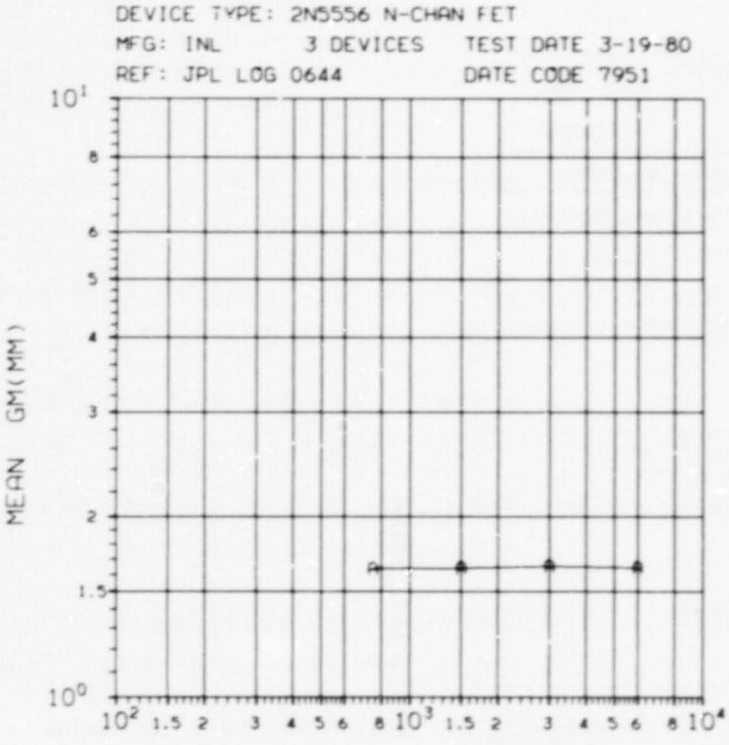
INITIAL MEAN VALUE GM-RATIO = 9.52×10^{-1}

DEVICE TYPE: 2N5196 DUAL N-CHAN FET
MFG: SIL 5 DEVICES TEST DATE 10-9-79
REF: JPL LOG 0497 DATE CODE 7623



(1) ΔVGS (VGS1-VGS2) IN MV; IN SITU VS DOSE

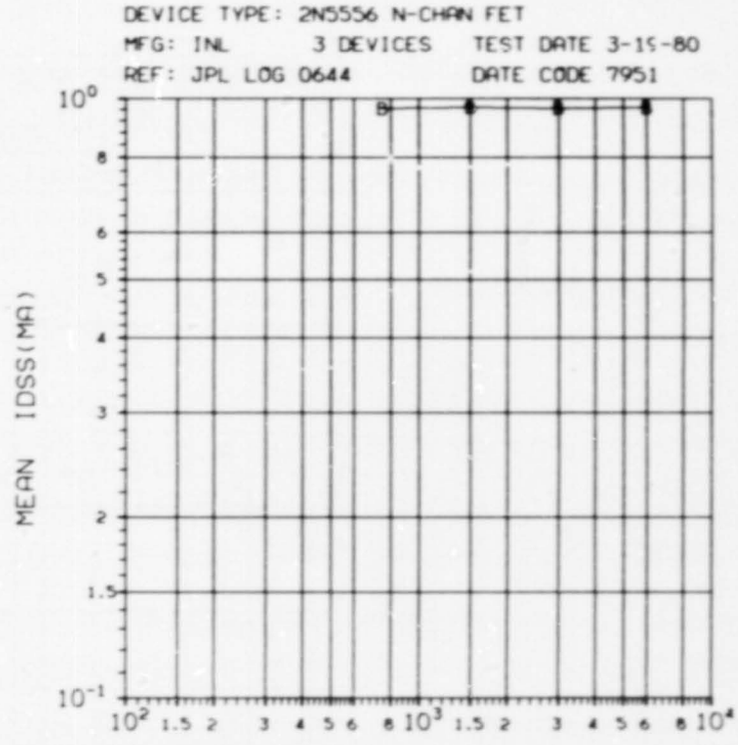
TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
A	2.080	2.151	2.237	2.306	2.242



(1) GM IN MILLIMHOS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.3239	.3259	.3302	.3288

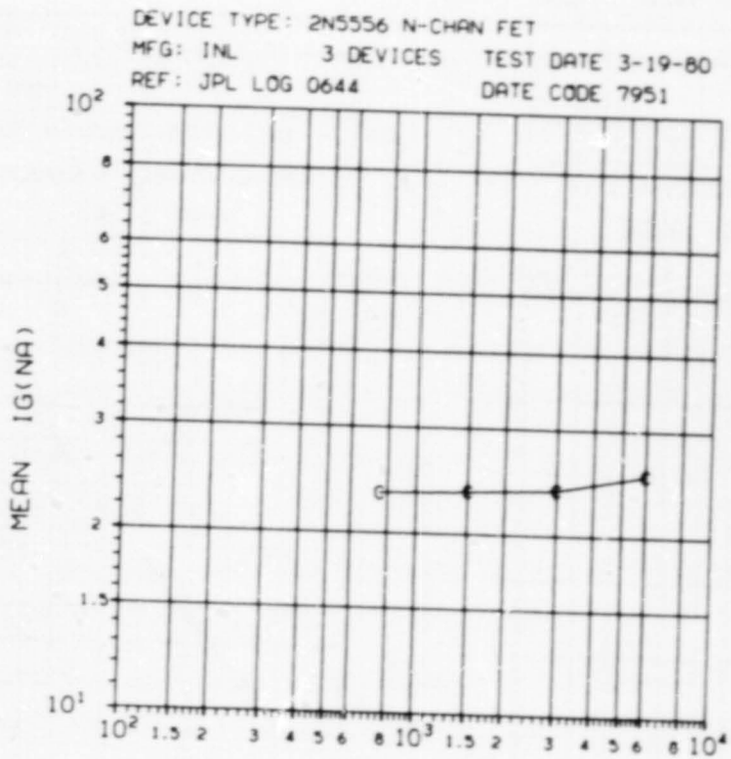
INITIAL MEAN VALUE GM(MM) = 1.63×10^{0}



(2) IDSS IN MA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	.1098	.1149	.1176	.1159

INITIAL MEAN VALUE IDSS(MA) = 9.72×10^{-1}

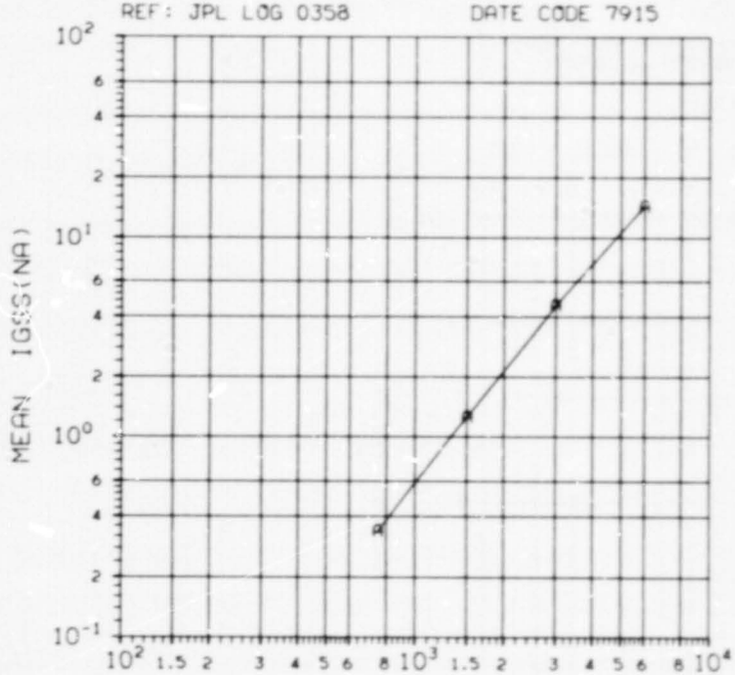


(3) IG IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
C	6.704	7.135	7.004	6.782

INITIAL MEAN VALUE IG(NA) = $2.19 \times 10^{+1}$

DEVICE TYPE: 2N6483 DUAL N CHAN FET
MFG: INL 8 DEVICES TEST DATE 6-19-79
REF: JPL LOG 0358 DATE CODE 7915

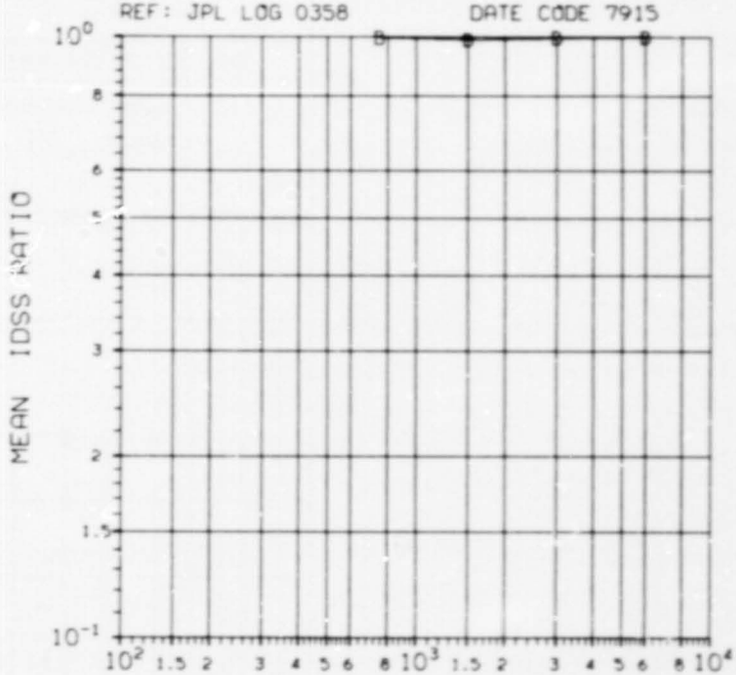


(1) IGSS (IN NANOAMPS); VDS=10V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.1109	.6071	2.403	12.01

INITIAL MEAN VALUE IGSS(NA) = 8.92×10^{-1}

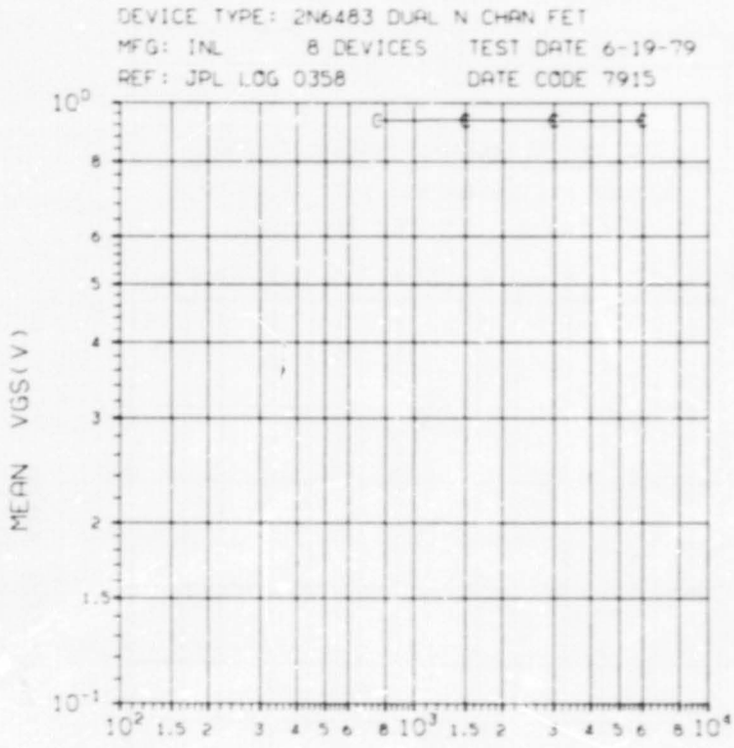
DEVICE TYPE: 2N6483 DUAL N CHAN FET
MFG: INL 8 DEVICES TEST DATE 6-19-79
REF: JPL LOG 0358 DATE CODE 7915



(2) IDSS1/IDSS2; VDS=10V, VGS=0 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	.0055	.0210	.0049	.0025

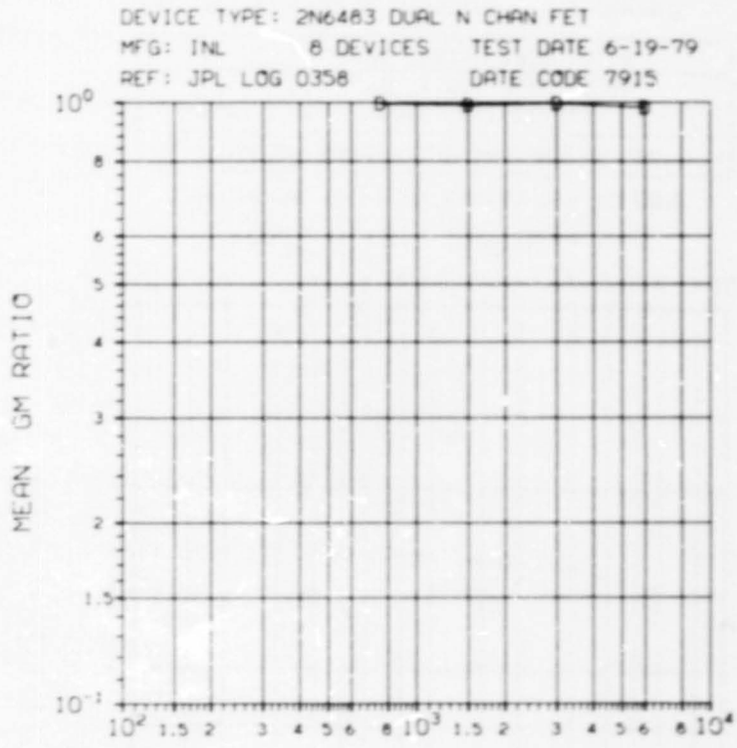
INITIAL MEAN VALUE IDSS RATIO = 9.98×10^{-1}



(3) VGS (IN VOLTS); VDS=10V, ID=300U VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
C	.3125	.3121	.3121	.3125

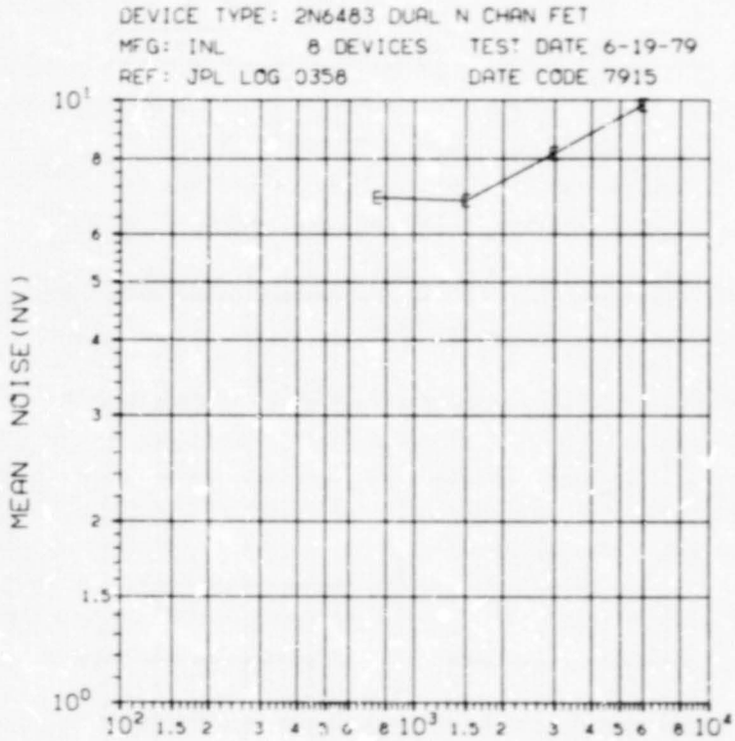
INITIAL MEAN VALUE VGS(V) = 9.29×10^{-1}



(4) GM1/GM2; VDS=10V, ID=300UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
D	.0052	.0210	.0047	.0323

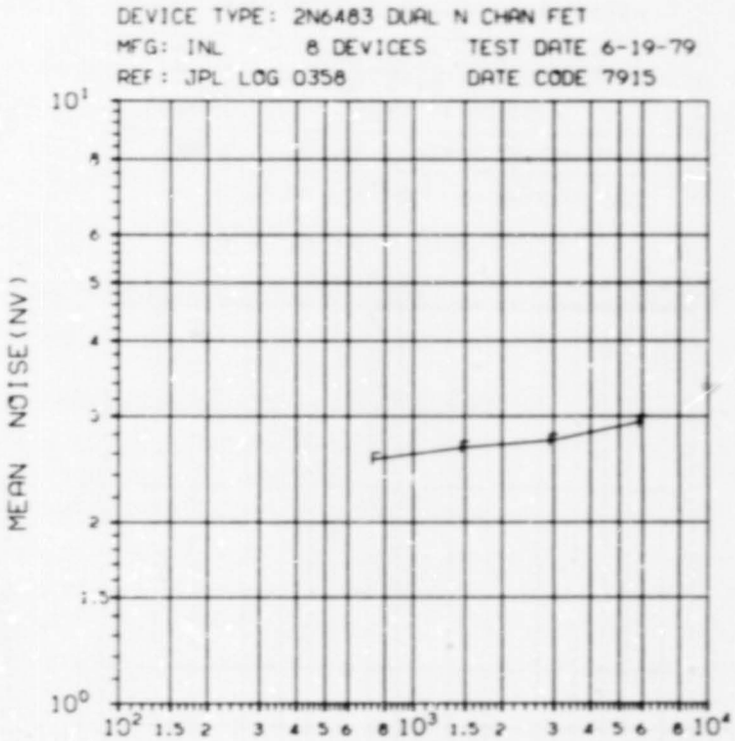
INITIAL MEAN VALUE GM RATIO = 9.92×10^{-1}



(5A) NOISE 10HZ (IN NANOVOLTS) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
E	.9562	1.028	1.896	1.738

INITIAL MEAN VALUE NOISE(NV) = 6.50×10^{0}

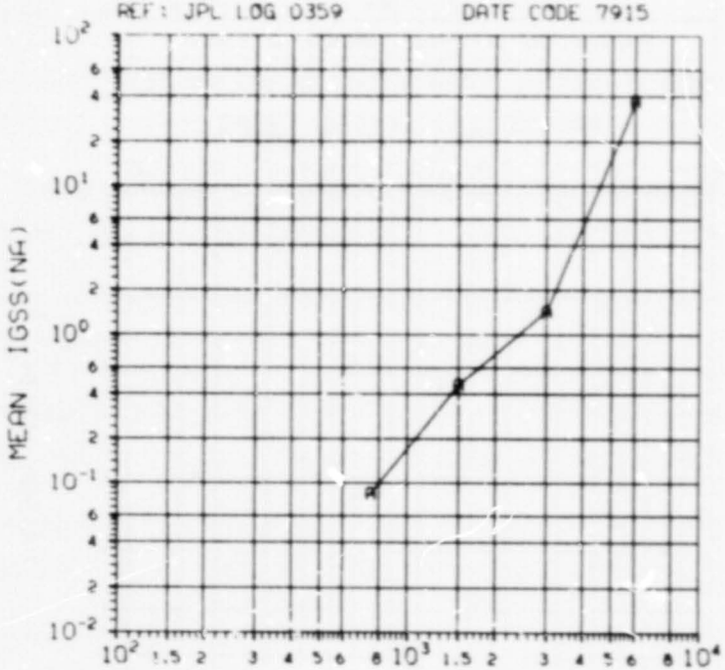


(5B) NOISE 100HZ(IN NANOVOLTS) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
F	.2726	.2615	.1923	.3159

INITIAL MEAN VALUE NOISE(NV) = 2.30×10^{0}

DEVICE TYPE: 2N6483 DUAL N CHAN FET
MFG: INL 8 DEVICES TEST DATE 6-15-79
REF: JPL LOG 0359 DATE CODE 7915

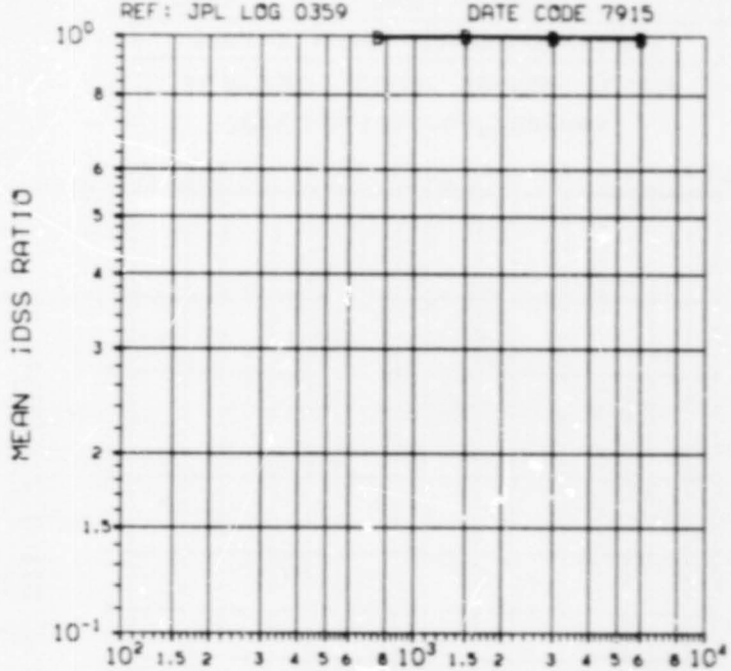


(1) IGSS (IN NANOAMPS); VDS=10V VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	75	1.50	3.00	6.00
A	.0275	.1289	.4619	10.52

INITIAL MEAN VALUE = 8.29×10^{-2}

DEVICE TYPE: 2N6483 DUAL N CHAN FET
MFG: INL 8 DEVICES TEST DATE 6-15-79
REF: JPL LOG 0359 DATE CODE 7915

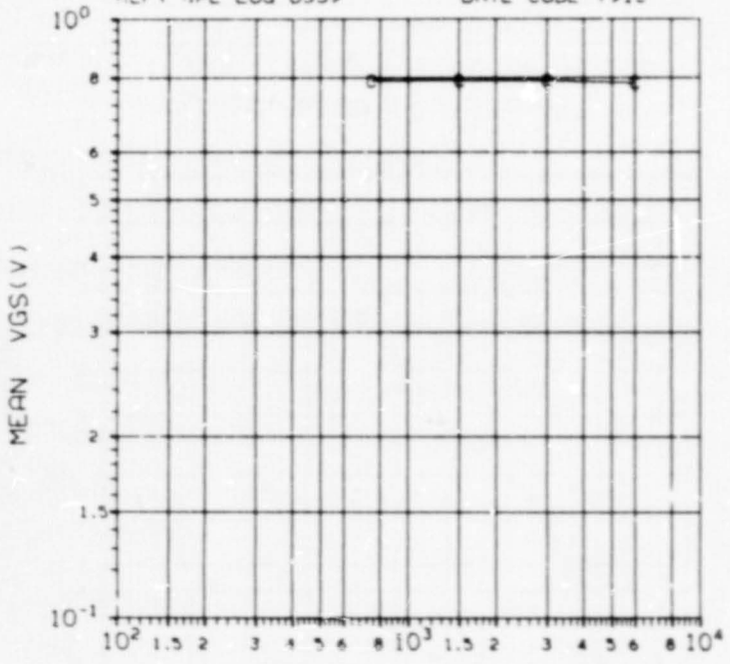


(2) IDSS1/IDSS2; VDS=10V, VGS=0 VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	.0076	.0040	.0145	.0077

INITIAL MEAN VALUE = 9.83×10^{-1}

DEVICE TYPE: 2N6483 DUAL N CHAN FET
MFG: INL 8 DEVICES TEST DATE 6-15-79
REF: JPL LOG 0359 DATE CODE 7915

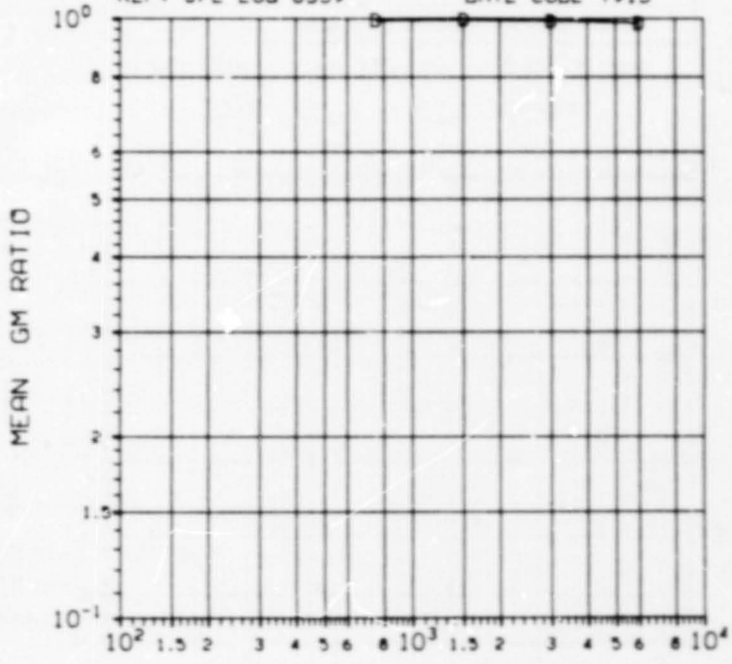


(3) VGS (IN VOLTS); VDS=10V, ID=300U VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
C	.0532	.0531	.0531	.0536

INITIAL MEAN VALUE = 7.82×10^{-1}

DEVICE TYPE: 2N6483 DUAL N CHAN FET
MFG: INL 8 DEVICES TEST DATE 6-15-79
REF: JPL LOG 0359 DATE CODE 7915

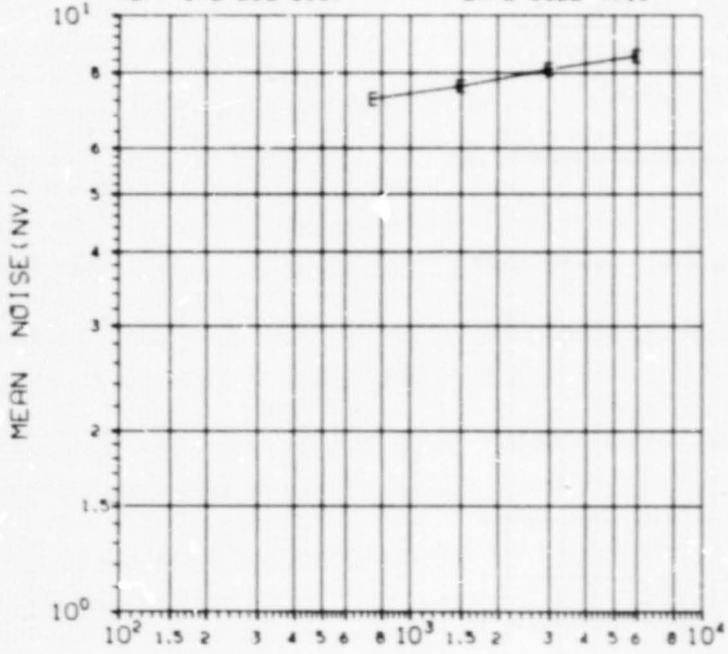


(4) GM1/GM2; VDS=10V, ID=300UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
D	.0076	.0040	.0145	.0186

INITIAL MEAN VALUE = 9.82×10^{-1}

DEVICE TYPE: 2N6483 DUAL N CHAN FET
MFG: INL 8 DEVICES TEST DATE 6-15-79
REF: JPL LOG 0359 DATE CODE 7915

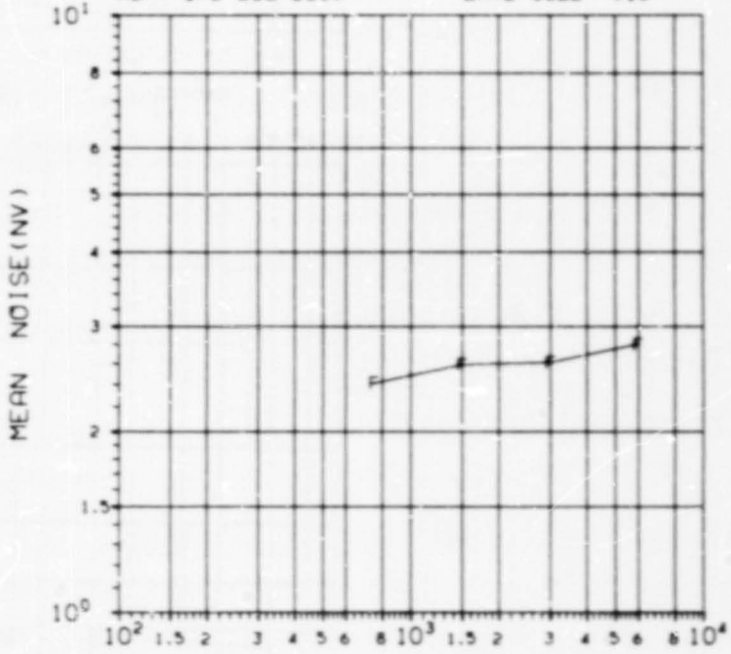


(5A) NOISE 10HZ (IN NANOVOLTS) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
E	.4751	.6676	.3603	.6042

INITIAL MEAN VALUE = 6.66×10^0

DEVICE TYPE: 2N6483 DUAL N CHAN FET
MFG: INL 8 DEVICES TEST DATE 6-15-79
REF: JPL LOG 0359 DATE CODE 7915

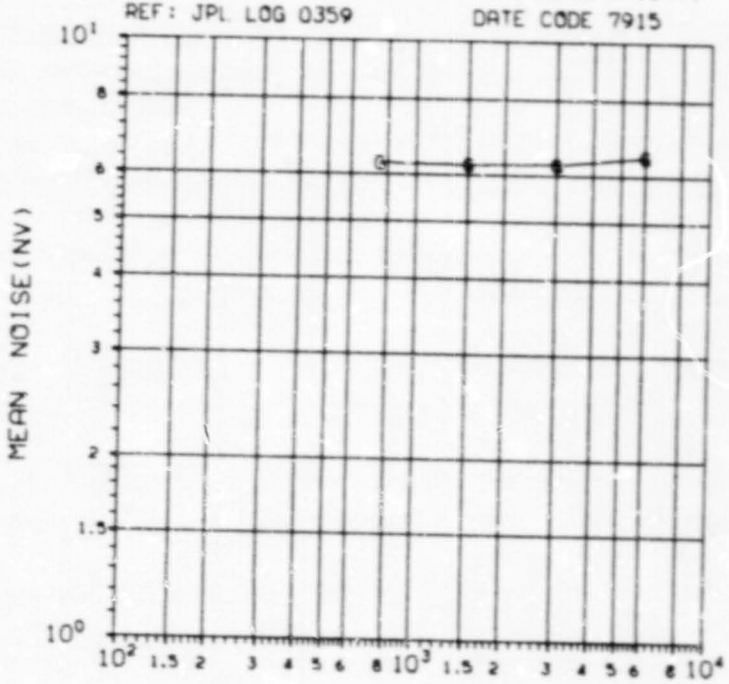


(5B) NOISE 100HZ (IN NANOVOLTS) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
F	.1642	.1458	.1356	.1195

INITIAL MEAN VALUE = 2.37×10^0

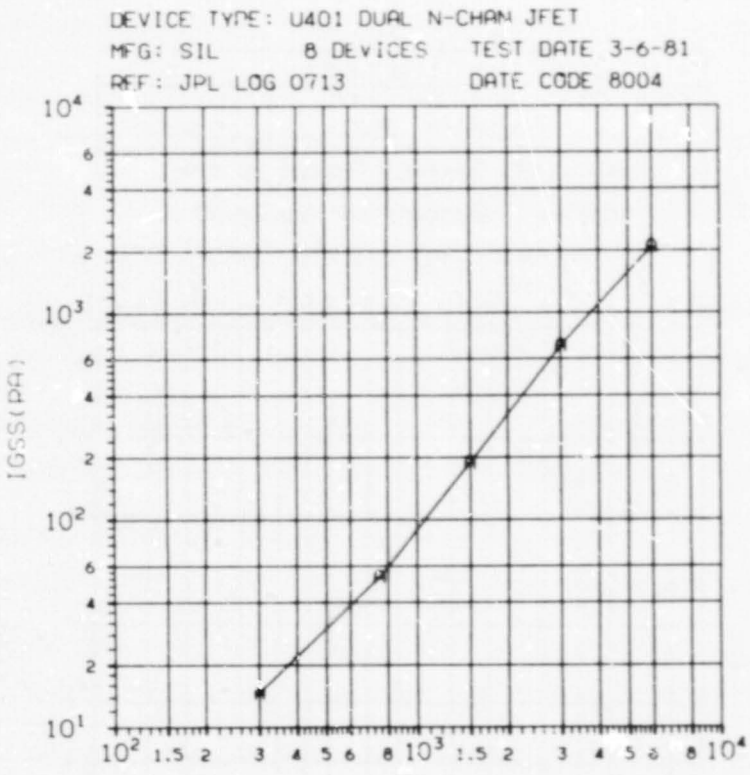
DEVICE TYPE: 2N6483 DUAL N CHAN FET
MFG: INL 8 DEVICES TEST DATE 6-15-79
REF: JPL LOG 0359 DATE CODE 7915



(5C) NOISE 1KHZ (IN NANOVOLTS) VS DOSE

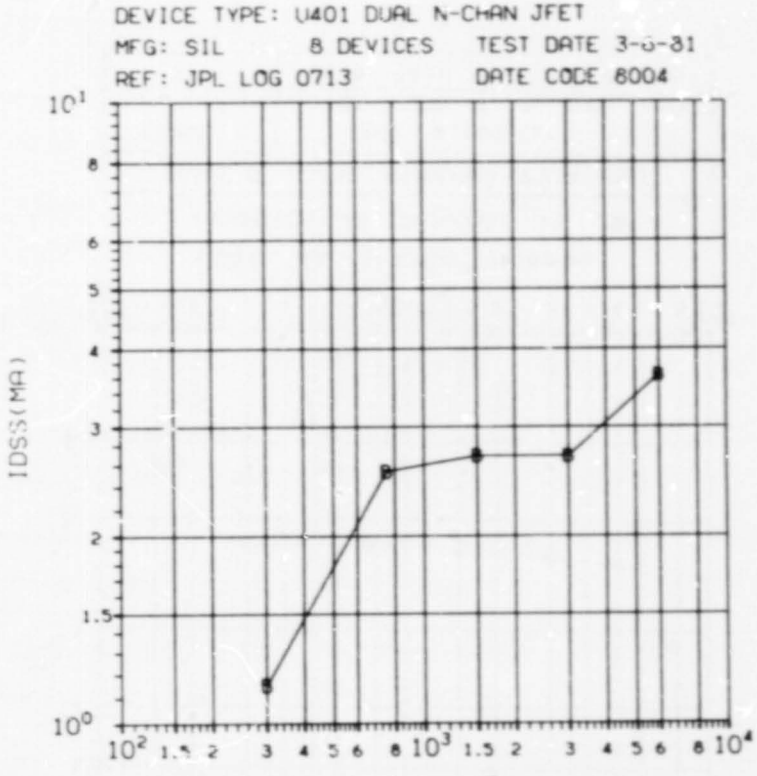
TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
G	.1302	.0916	.0926	.1069

INITIAL MEAN VALUE = 6.26×10^0



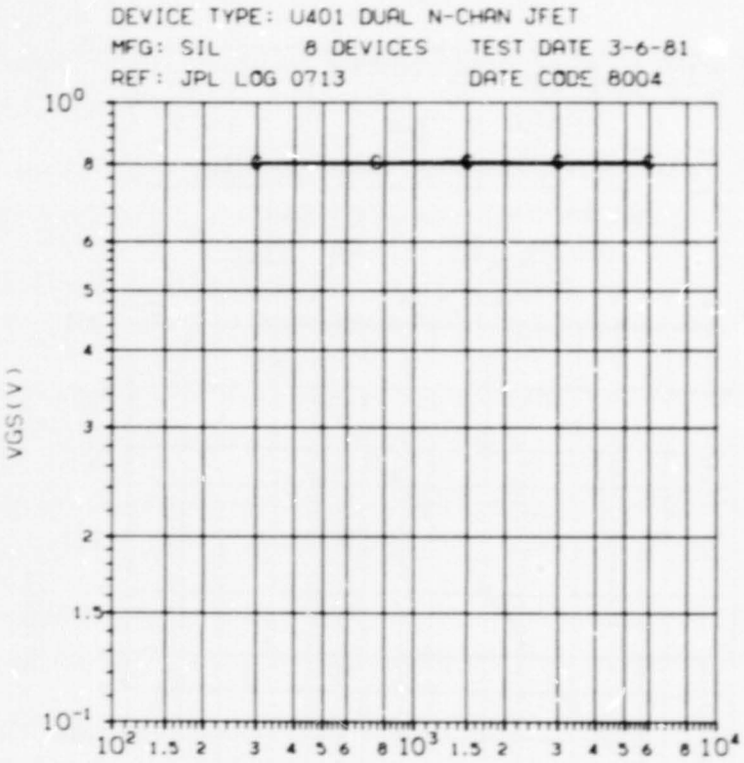
(1)IGSS(VDS=0,VGS=-10V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
A	3.659	13.30	53.56	223.7	691.6



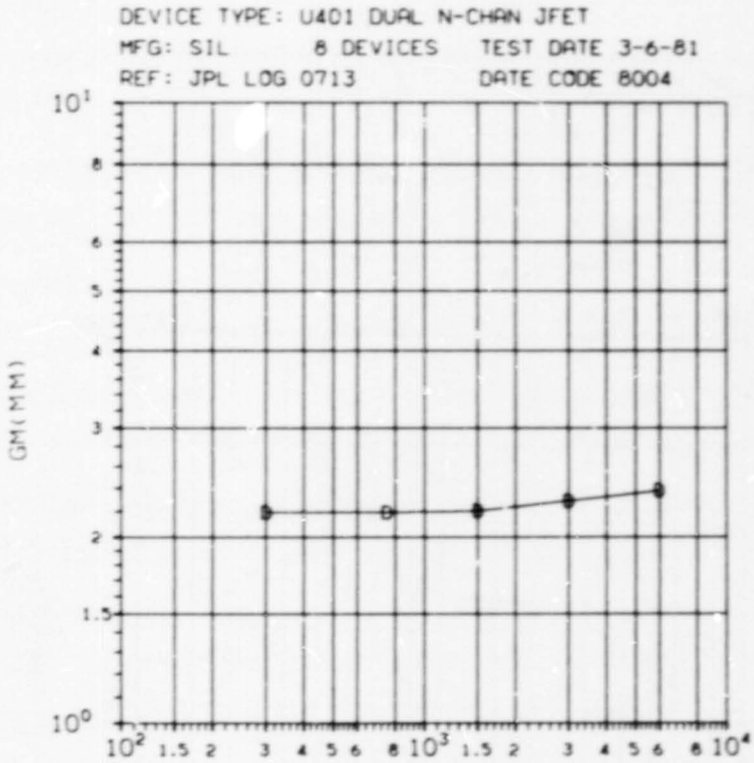
(2)IDSS(VDS=10V,VGS=0) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
B	.3874	1.104	1.216	1.218	2.146



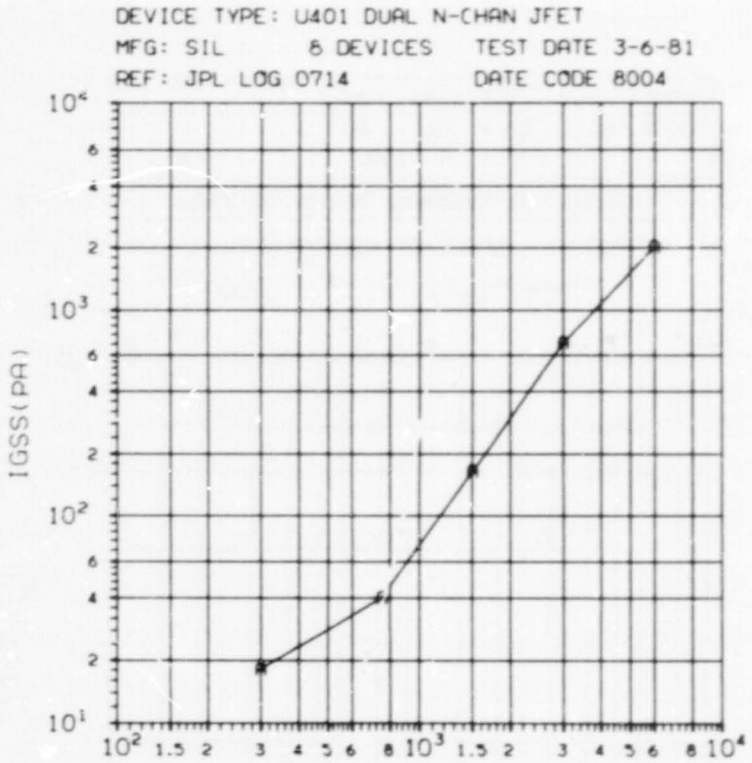
(3)VGS(VDS=10V,ID=300UA) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
C	.3520	.3511	.3516	.3512	.3516



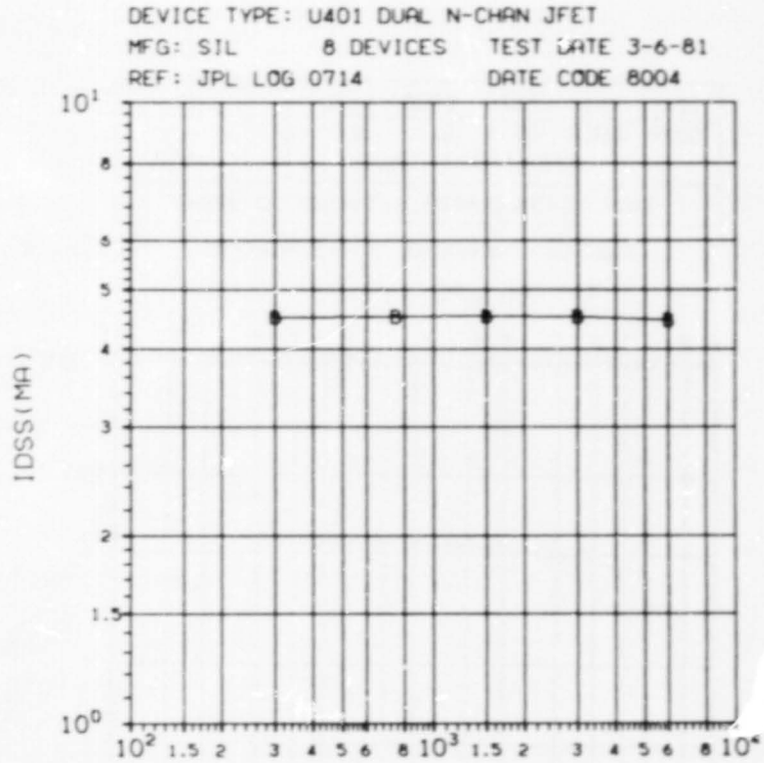
(4)GM(VDS=10V,ID=300UA) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
D	.3616	.3431	.3493	.3712	.3665



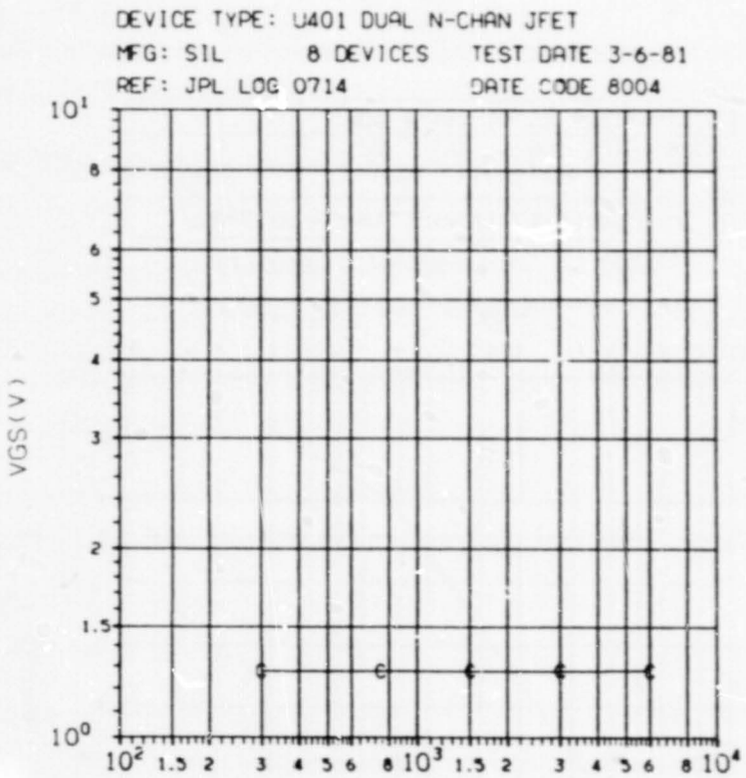
(1)IGSS(VDS=0,VGS=-10V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
A	2.805	8.643	55.55	239.8	631.8



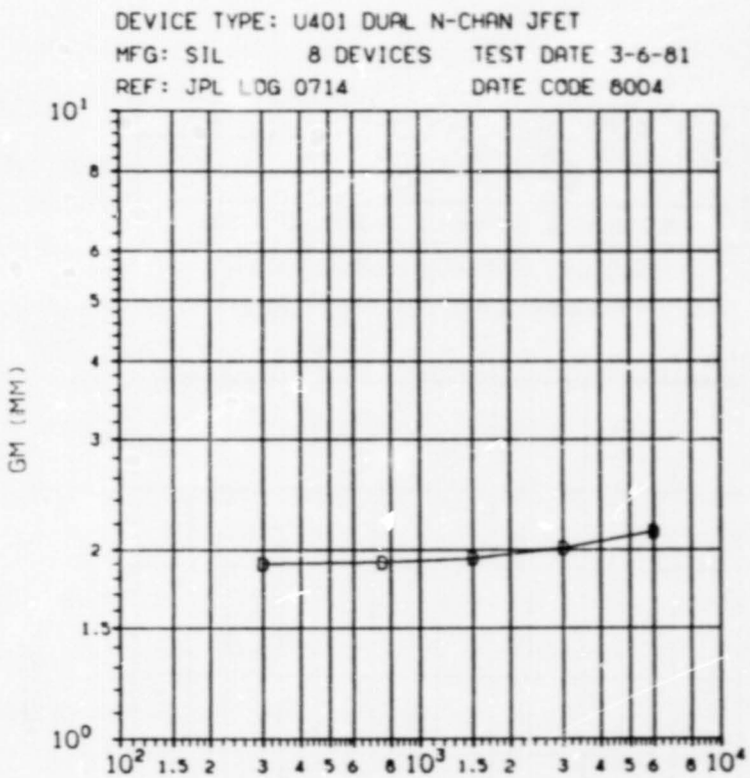
(2)IDSS(VDS=10V,VGS=0) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
B	.6288	.6366	.6520	.6439	.6076



(3)VGS(VDS=10V, ID=300UA) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
C	.1562	.1562	.1562	.1582	.1565



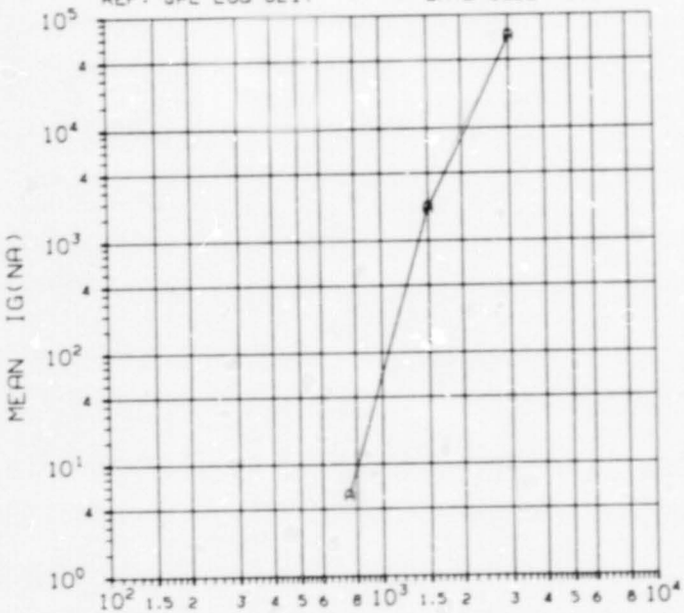
(4)GM(VDS=10V, ID=300UA) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
D	.0283	.0283	.0315	.0564	.1436

E. SILICON-CONTROLLED RECTIFIERS (SCRs)

Because of the limited use, the SCR type of device was tested to limited special requirements.

DEVICE TYPE: 2N3032 SILICON CONTROLLED RECT.
MFG: UTR 3 DEVICES TEST DATE 10-10-78
REF: JPL LOG 0217 DATE CODE 7515

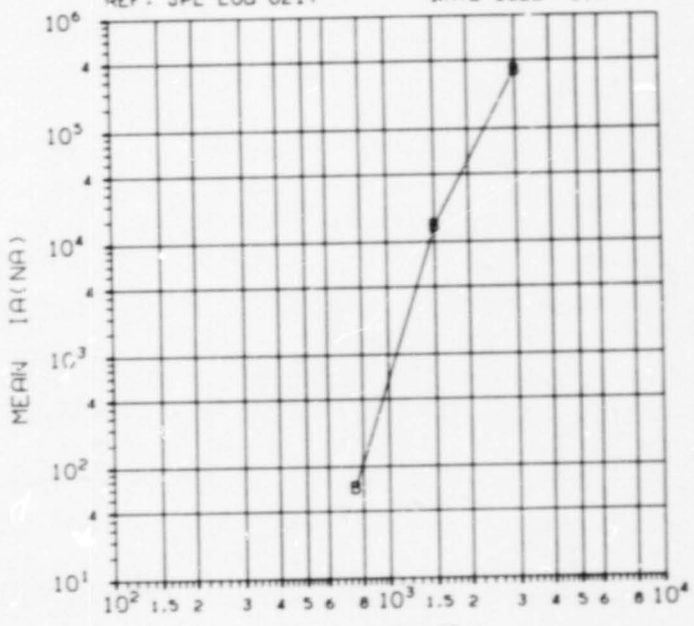


(1) GATE LEAKAGE(NA) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00
A	8.448	1786.	

INITIAL MEAN VALUE IG(NA) = 6.07×10^{-2}

DEVICE TYPE: 2N3032 SILICON CONTROLLED RECT.
MFG: UTR 3 DEVICES TEST DATE 10-10-78
REF: JPL LOG 0217 DATE CODE 7515

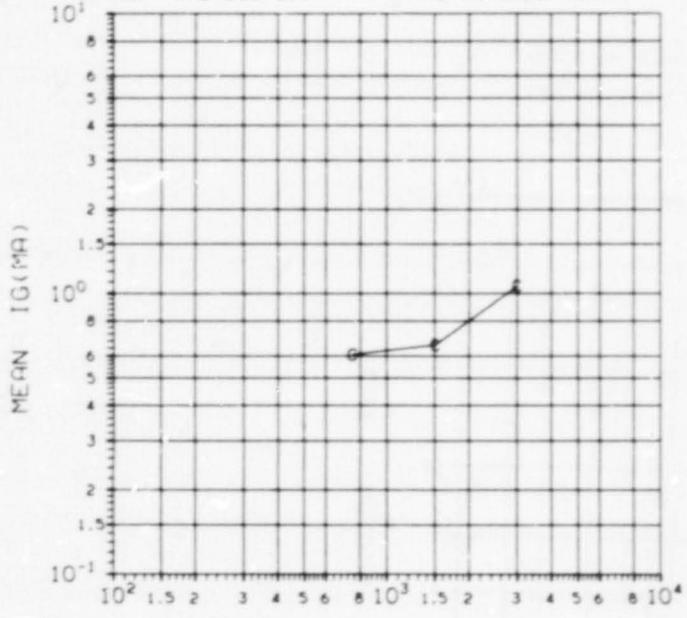


(2) ANODE LEAKAGE(NA) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00
B	99.94		

INITIAL MEAN VALUE IA(NA) = 1.28×10^{-1}

DEVICE TYPE: 2N3032 SILICON CONTROLLED RECT.
MFG: UTR 3 DEVICES TEST DATE 10-10-78
REF: JPL LOG 0217 DATE CODE 7515

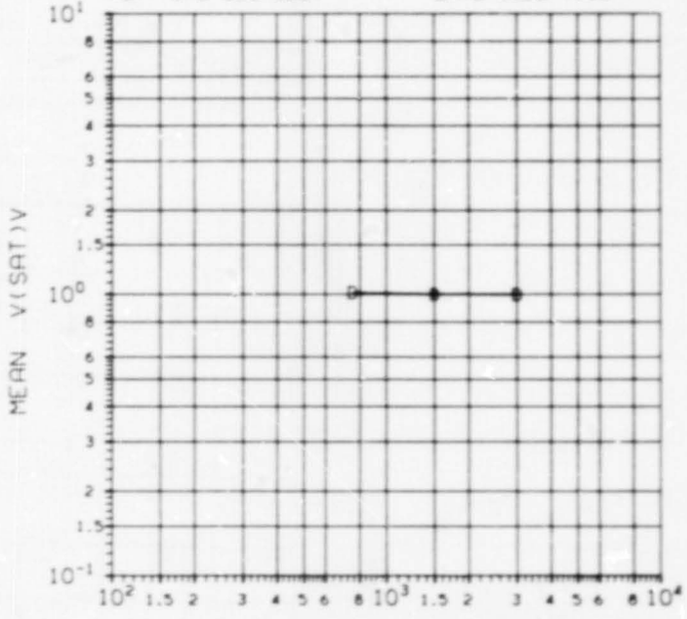


(3) GATE CURRENT VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00
C	.1172	.0530	.2413

INITIAL MEAN VALUE IG(MA) = 5.44×10^{-1}

DEVICE TYPE: 2N3032 SILICON CONTROLLED RECT.
MFG: UTR 3 DEVICES TEST DATE 10-10-78
REF: JPL LOG 0217 DATE CODE 7515

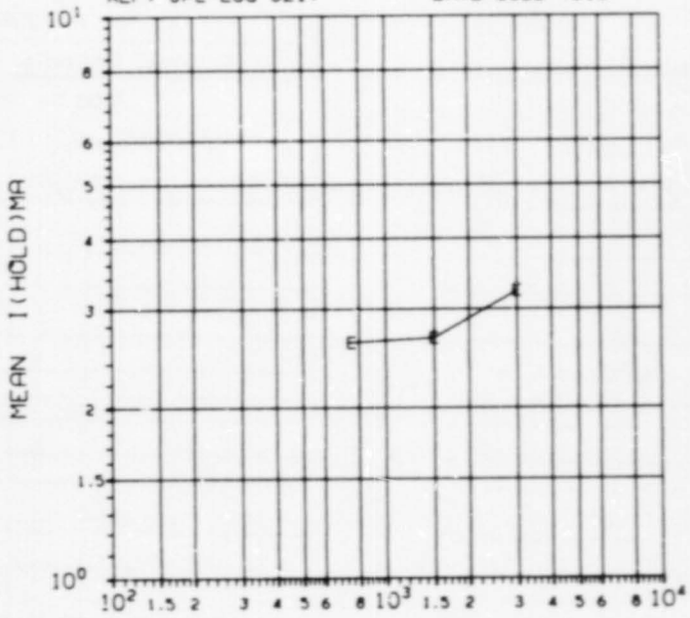


(4) SATURATION VOLTAGE(V) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00
D	.0040	.0162	.0318

INITIAL MEAN VALUE V(SAT)V = 9.99×10^{-1}

DEVICE TYPE: 2N3032 SILICON CONTROLLED RECT.
MFG: UTR 3 DEVICES TEST DATE 10-10-78
REF: JPL LOG 0217 DATE CODE 7515



DOSE, Gy(Si) Co^{60} Gammas

(5) HOLDING CURRENT (MA) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00
E	.1155	.1607	.4163

INITIAL MEAN VALUE I(HOLD)MA = 2.60×10^{0}

DEVICE: 2N3032

TYPE: SCR

MANUFACTURER: UTR

DATE CODE: 7426

DEVICES TESTED: 6

TEST DATE: 11-13-78

SOURCE: 2.5 MeV Electrons

LOG NUMBER: 0242

RADIATION BIAS CONDITIONS:

Anode = 10 volts
Gate = 1 kΩ to ground
Cathode = 220 Ω to ground

RESULTS: Worst-Case Parameter Values, V_A = 10 volts

Total Dose	I_G, pA (Maximum)	I_A, pA (Maximum)	I_{GT}, μA (Maximum)	V_{SAT}, V (Maximum)	I_{HOLD}, mA (Minimum)
Initial	1.0×10^2	1.0×10^2	18	0.96	1.15
300 Gy(Si)	1.1×10^2	2.9×10^2	20	0.96	1.16
750 Gy(Si)	6.5×10^3	1.4×10^5	27	0.96	1.16
1500 Gy(Si)	3.2×10^6	9.5×10^6	85	0.94	1.22
3000 Gy(Si)	2.2×10^8	5.9×10^3	558	0.96	1.40

DEVICE: 2N6138

TYPE: Programmable Unijunction Transistor (PUT)

MANUFACTURER: UTR

DATE CODE: None

DEVICES TESTED: 3

TEST DATE: 11-14-78

SOURCE: 2.5 MeV Electrons

LOG NUMBER: 0225A

RADIATION BIAS CONDITIONS: Anode = 30 kΩ to ground
Gate = 10 kΩ to 10 volts
Cathode = 510 Ω to ground

RESULTS: Worst-Case Parameter Values, V_G = 10 volts

Total Dose	I_C, pA (Maximum)	I_A[a], pA (Maximum)	V_A, V (Maximum)	V_{SAT}, V (Maximum)	I_G, μA (Maximum)	I_{HOLD}, μA (Minimum)
Initial	111	<200	10.46	0.788	1000	445
300 Gy(Si)	83	<200	10.44	0.796	999	476
750 Gy(Si)	130	<200	10.47	0.795	999	447
1500 Gy(Si)	300	<200	10.78	0.794	999	483
3000 Gy(Si)	850	<200	10.53	0.795	999	658

[a]Noise limited the resolution of the I_A measurement.

DEVICE: 2N6138

TYPE: Programmable Unijunction Transistor (PUT)

MANUFACTURER: UTR

DATE CODE: None

DEVICES TESTED: 3

TEST DATE: 11-14-78

SOURCE: 2.5 MeV Electrons

LOG NUMBER: 0225B

RADIATION BIAS CONDITIONS:

Anode = open
Gate = open
Cathode = ground

RESULTS: Worst-Case Parameter Values, V_A = 10 volts

Total Dose	I_G, pA (Maximum)	I_A[a], pA (Maximum)	V_A, V (Maximum)	V_{SAT}, V (Maximum)	I_G, μA (Maximum)	I_{HOLD}, μA (Minimum)
Initial	63	<200	10.45	0.793	999	496
300 Gy(Si)	85	<200	10.46	0.799	999	531
750 Gy(Si)	125	<200	10.43	0.793	999	497
1500 Gy(Si)	150	<200	10.46	0.797	997	524
3000 Gy(Si)	130	<200	10.47	0.797	999	584

[a]Noise limited the resolution of the I_A measurement.

DEVICE: 2N6138

TYPE: Programmable Unijunction Transistor (PUT)

MANUFACTURER: UTR

DATE CODE: 7720

DEVICES TESTED: 5

TEST DATE: 3-15-79

SOURCE: 1.25 MeV Gamma

LOG NUMBER: 0329A

RADIATION BIAS CONDITIONS:

Anode = 30 kΩ to ground
Gate = 10 volts
Cathode = 20 Ω to ground

RESULTS: Worst-Case Parameter Values, V_G = 10 volts

Total Dose	I_{GAO}, nA (Maximum)	I_{GKR}, nA (Maximum)	V_{OUT}, V (Maximum)
Initial	0.18	0.19	8.8
300 Gy(Si)	0.23	0.23	8.8
750 Gy(Si)	0.27	0.27	8.8
1500 Gy(Si)	0.30	0.30	8.8
3000 Gy(Si)	0.44	1.1	8.8
6000 Gy(Si)	1.6	3600	8.6

DEVICE: 2N6138

TYPE: Programmable Unijunction Transistor (PUT)

MANUFACTURER: UTR

DATE CODE: 7720

DEVICES TESTED: 5

TEST DATE: 3-15-79

SOURCE: 1.25 MeV Gamma

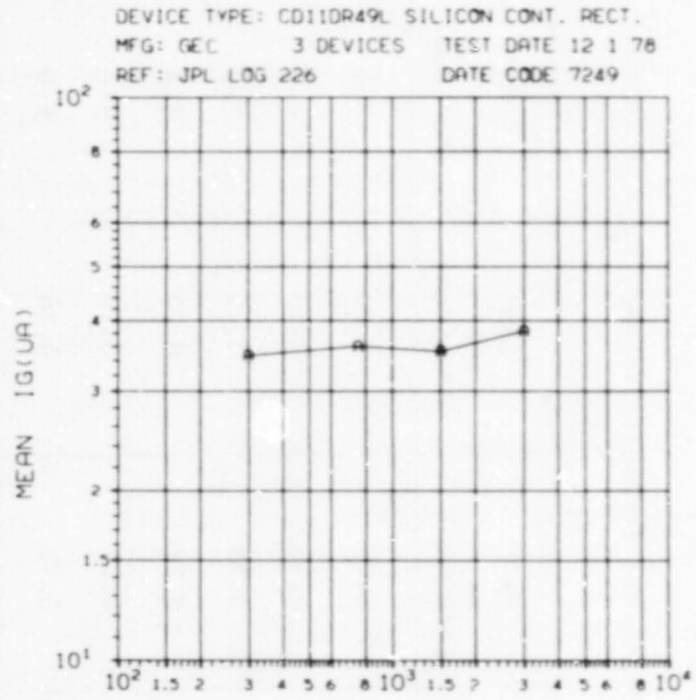
LOG NUMBER: 0329B

RADIATION BIAS CONDITIONS:

Anode = 30 kΩ to ground
Gate = 20 kΩ to ground
Cathode = 20 Ω to ground

RESULTS: Worst-Case Parameter Values, V_G = 10 volts

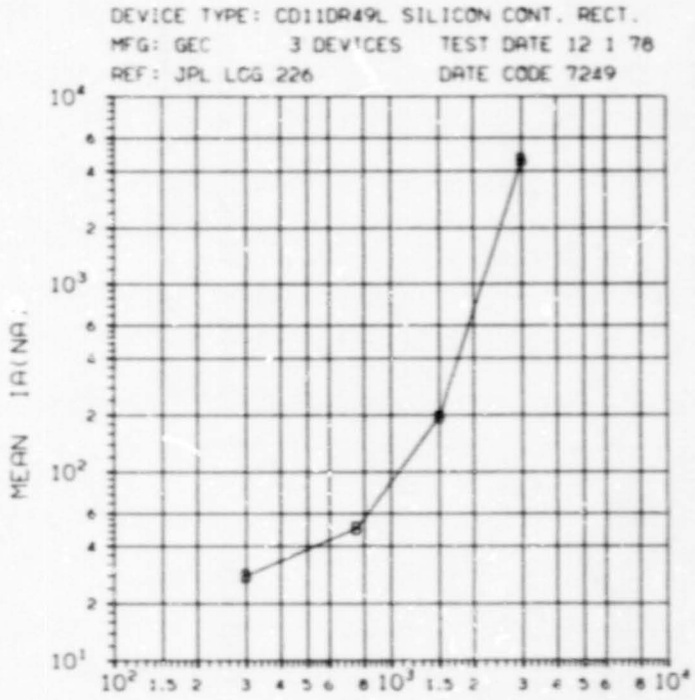
Total Dose	I_{GAO}, nA (Maximum)	I_{GKR}, nA (Maximum)	V_{OUT}, V (Maximum)
Initial	0.20	0.20	8.6
300 Gy(Si)	0.26	0.30	8.6
750 Gy(Si)	0.28	0.32	8.6
1500 Gy(Si)	0.28	0.32	8.8
3000 Gy(Si)	0.28	0.30	8.8
6000 Gy(Si)	0.32	0.36	8.8



(1)IG LEAKAGE (VG=0,RL=0) IN UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.30	.75	1.50	3.00
A	32.21	33.28	32.77	35.90

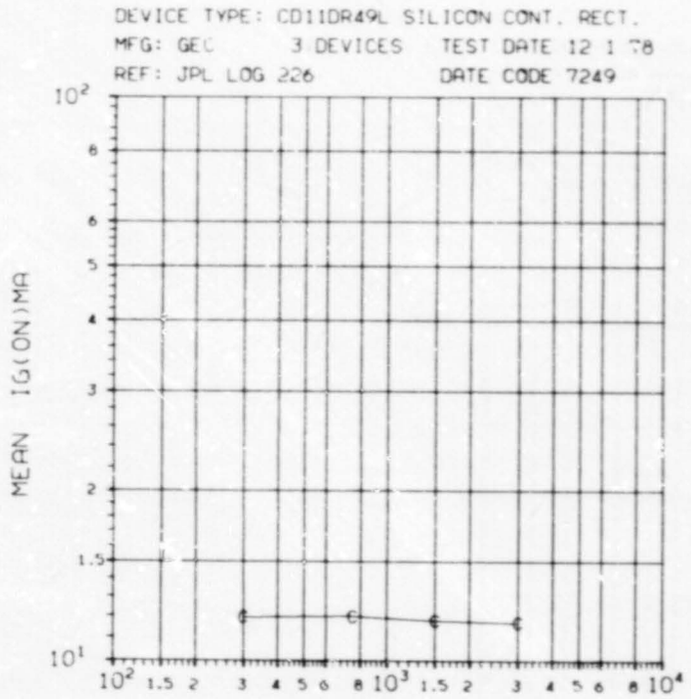
INITIAL MEAN VALUE IG(UA) = 2.10×10^{-1}



(2)IA LEAKAGE (VG=0,RL=0) IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.30	.75	1.50	3.00
B	26.81	42.18	221.9	6698.

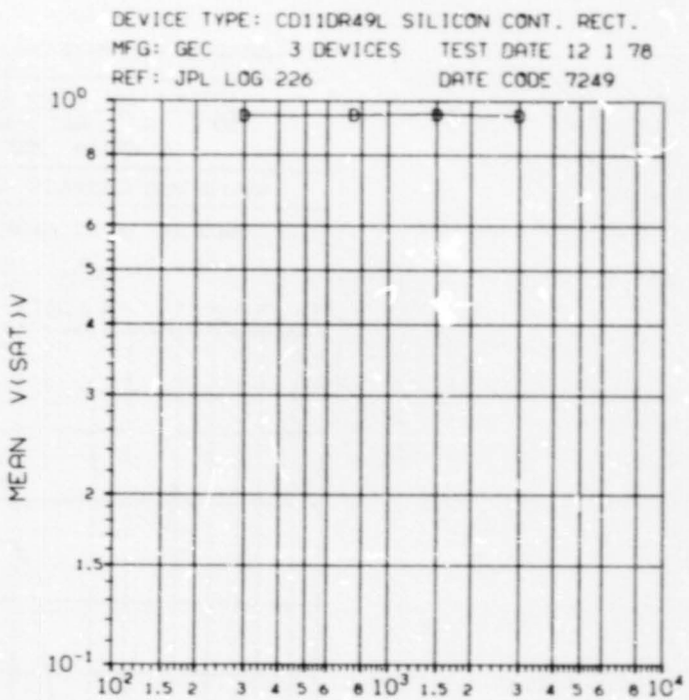
INITIAL MEAN VALUE IA(NA) = $4.48 \times 10^{+1}$



(3)IG TURN ON IN MA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.30	.75	1.50	3.00
C	2.044	2.302	2.100	2.092

INITIAL MEAN VALUE IG(ON)MA = $1.19 \times 10^{+1}$

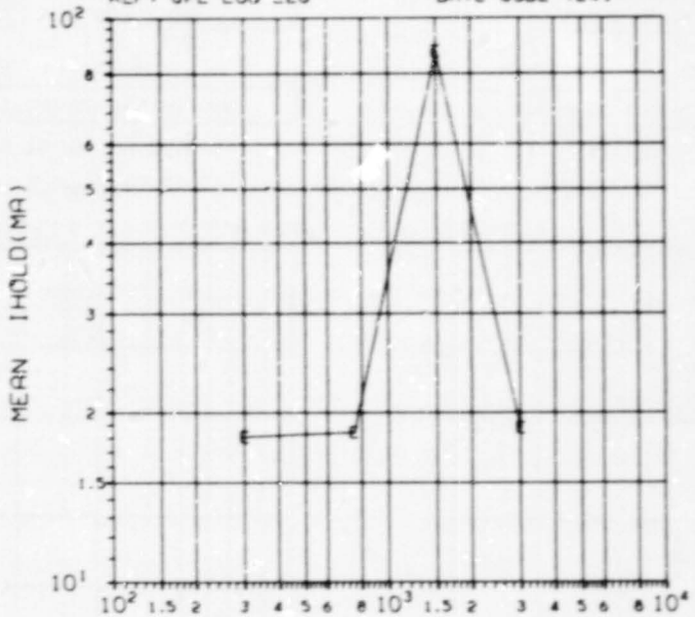


(4)V SAT (IA=100MA) IN VOLTS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.30	.75	1.50	3.00
D	.0784	.0593	.0711	.0756

INITIAL MEAN VALUE V(SAT)V = 9.34×10^{-1}

DEVICE TYPE: CD11DR49L SILICON CONT. RECT.
MFG: GEC 3 DEVICES TEST DATE 12 1 78
REF: JPL LOG 226 DATE CODE 7249



DOSE, Gy(Si) Co^{60} Gammas

(5)I HOLD (VG=0) IN MA VS DOSE

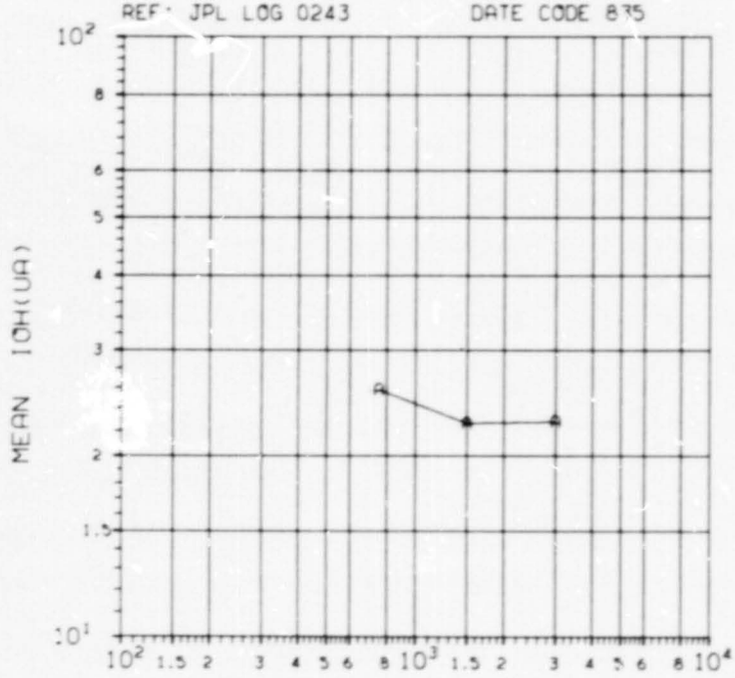
TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.30	.75	1.50	3.00
E	4.173	4.212	123.3	4.051

INITIAL MEAN VALUE IHOLD(MA) = 1.81×10^{-1}

F. OPTICAL DEVICES

The optical devices consist of light-emitting diodes, phototransistors, and optical isolators.

DEVICE TYPE: 6N134 OPTICAL COUPLER
MFG: HPA 6 DEVICES TEST DATE 11-6-78
REF: JPL LOG 0243 DATE CODE 835

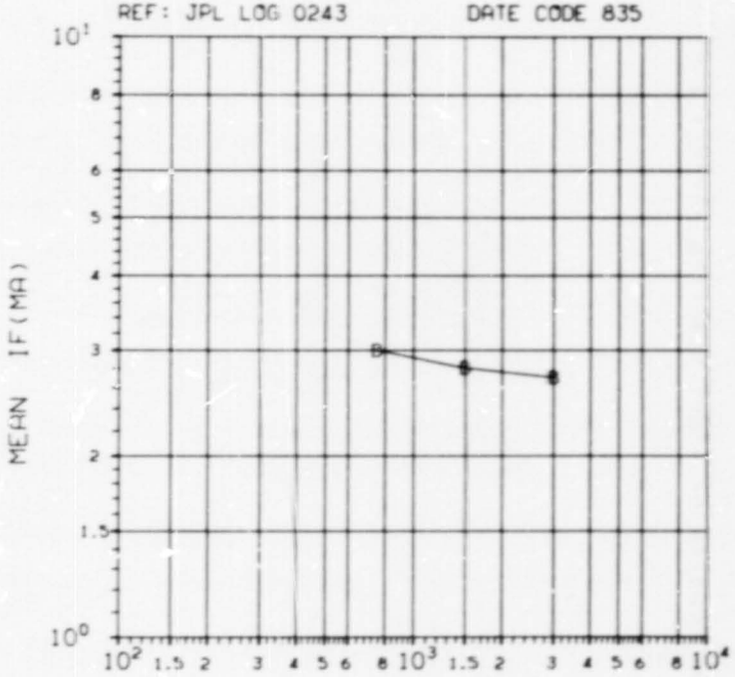


(1) IOH, IF=250UA, RL=500 OHMS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kiloGy(Si) .75 1.50 3.00
A	4.548 5.123 6.044

INITIAL MEAN VALUE IOH(UA) = $2.88 \times 10^{+1}$

DEVICE TYPE: 6N134 OPTICAL COUPLER
MFG: HPA 5 DEVICES TEST DATE 11-8-78
REF: JPL LOG 0243 DATE CODE 835

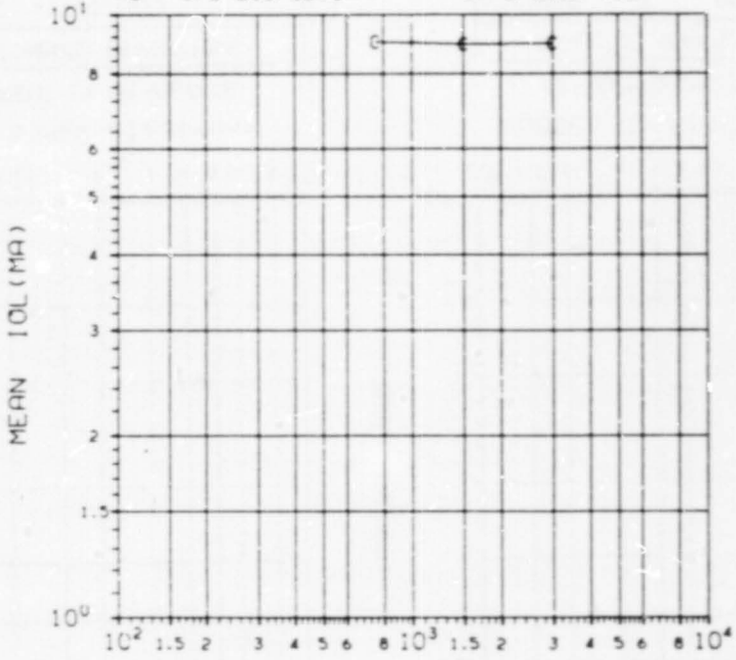


(2) IF, RL=500 OHMS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, kiloGy(Si) .75 1.50 3.00
B	.8385 .7409 .7423

INITIAL MEAN VALUE IF(MA) = 3.02×10^{0}

DEVICE TYPE: 6N134 OPTICAL COUPLER
MFG: HPA 6 DEVICES TEST DATE 11-8-76
REF: JPL LOG 0243 DATE CODE 835

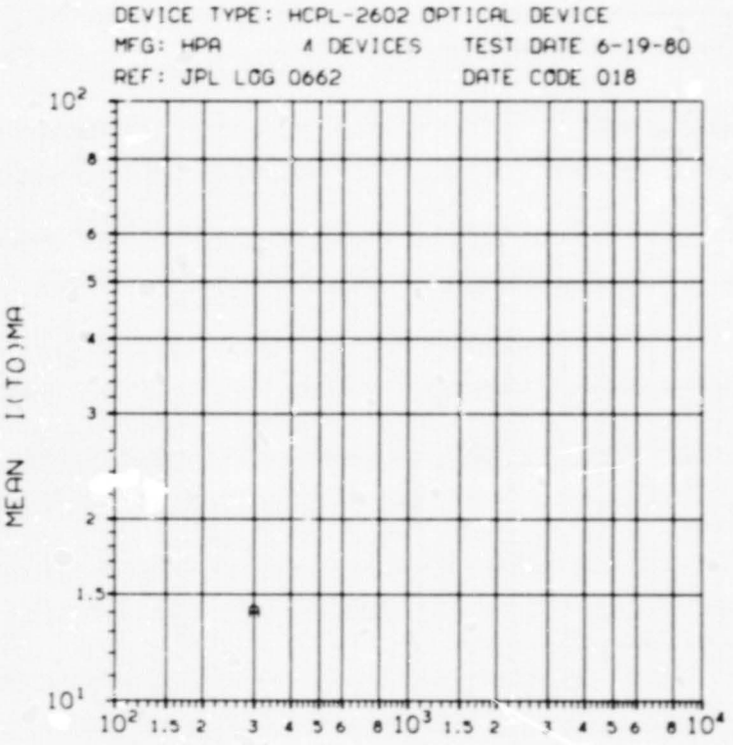


DOSE, Gy(Si) 2.5 MeV electrons

(3) IOL, IF=12.5MA, RL=500 OHMS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS			
CURVE	DOSE, kiloGy(Si) .75	1.50	3.00
C	.0816	.0837	.0816

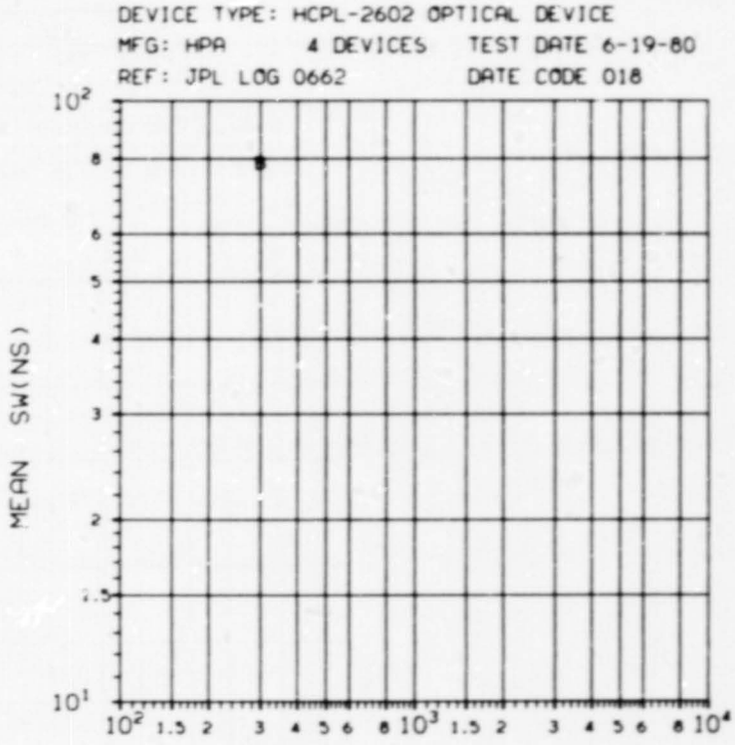
INITIAL MEAN VALUE IOL(MA) = 9.02×10^{0}



(1) THRESHOLD CURRENT IN MA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si) .30	.75	1.50	3.00	6.00
A	11.52 FAIL				

INITIAL MEAN VALUE I(TO)MA = 7.92×10^{0}

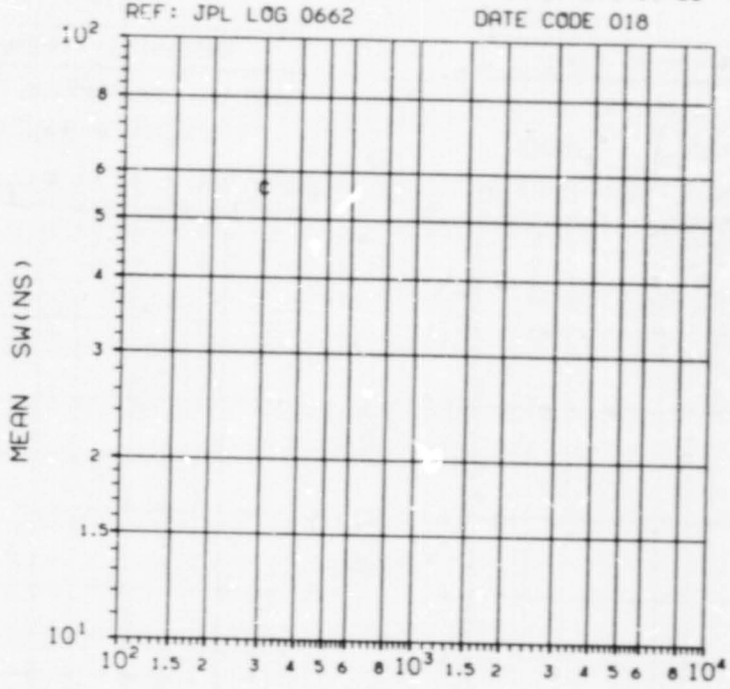


(2) SWITCHING TIME-1 IN NS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si) .30	.75	1.50	3.00	6.00
B	3.775 FAIL				

INITIAL MEAN VALUE SW(NS) = $7.80 \times 10^{+1}$

DEVICE TYPE: HCPL-2602 OPTICAL DEVICE
MFG: HPA 4 DEVICES TEST DATE 6-19-80
REF: JPL LOG 0662 DATE CODE 018

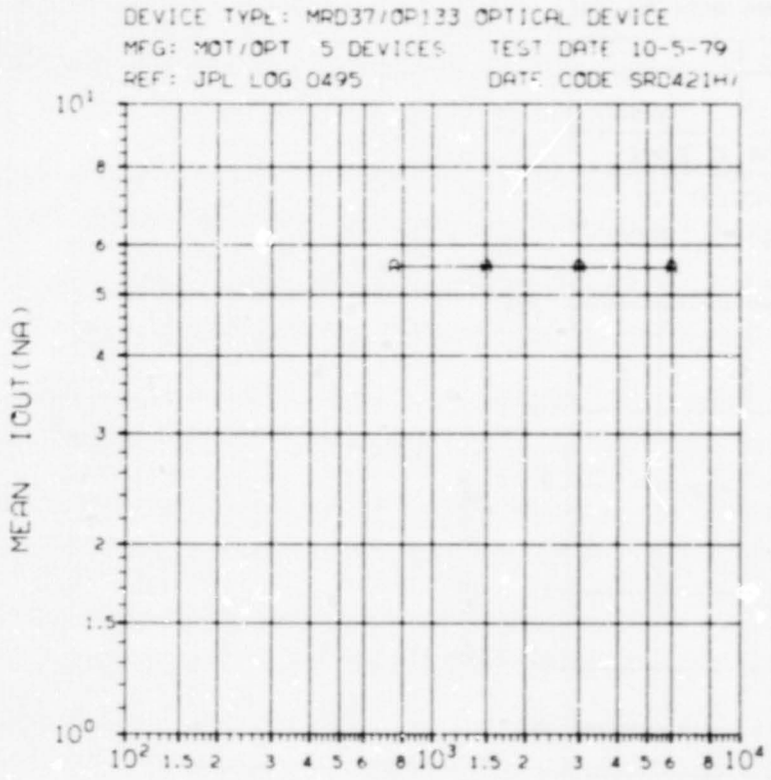


DOSE, Gy(Si) 2.5 MeV electrons

(3) SWITCHING TIME-2 IN NS VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, kiloGy(Si)				
	.30	.75	1.50	3.00	6.00
C	9.179 FAIL				

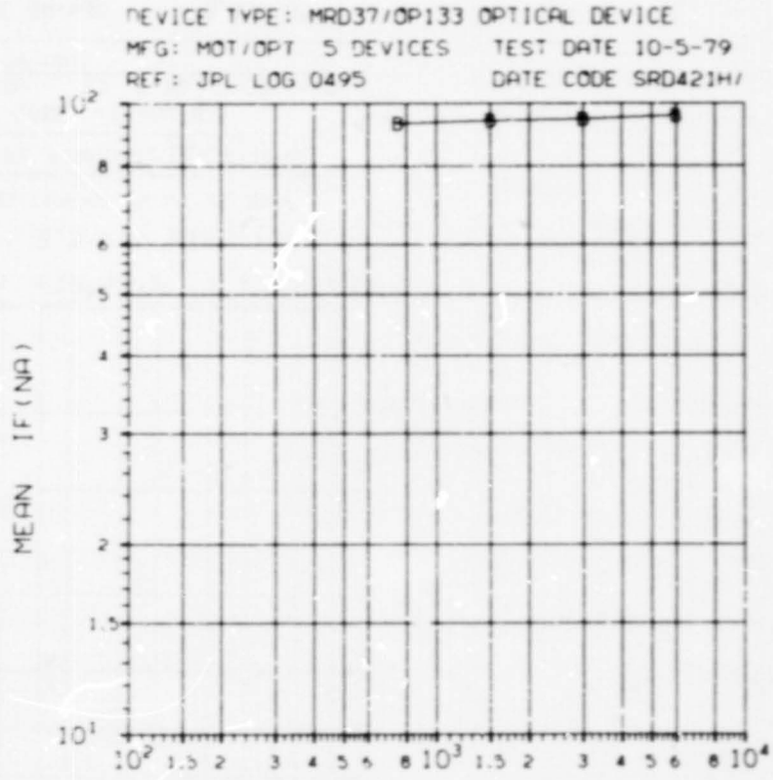
INITIAL MEAN VALUE SW(NS) = $5.52 \times 10^{+1}$



(1) IOUT IN NA; IN SITU MEASUREMENT VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0548	.0548	.0447	.0274

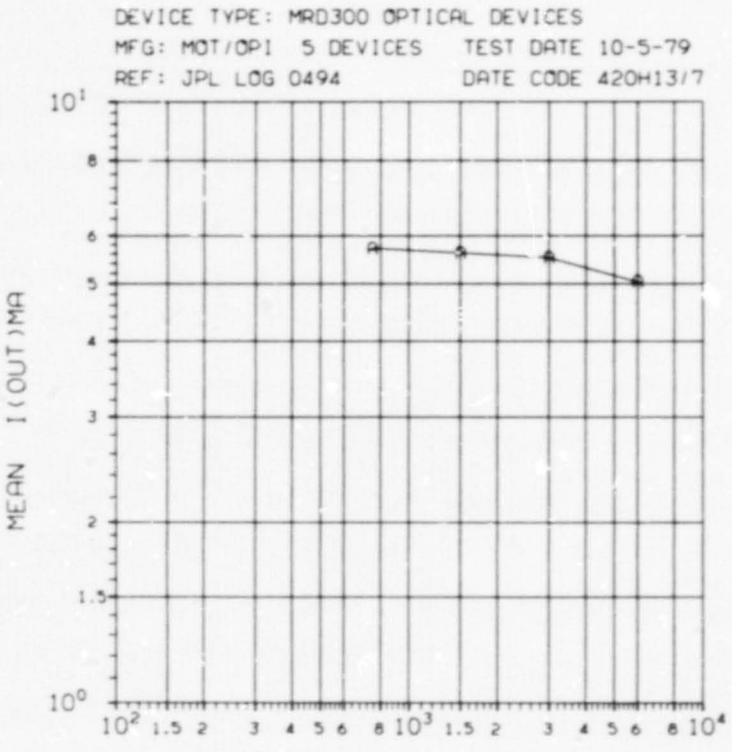
INITIAL MEAN VALUE IOUT(NA) = 5.54×10^{0}



(2) IF IN NA; IN SITU MEASUREMENT VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	1.000	1.000	1.414	1.204

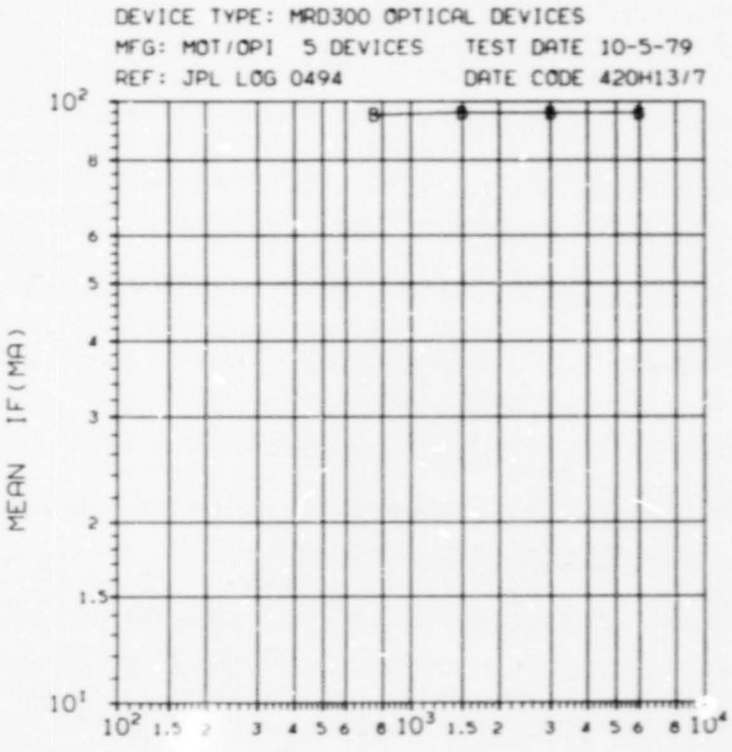
INITIAL MEAN VALUE IF(NA) = $9.48 \times 10^{+1}$



(1) IOUT IN MA; IN SITU MEASUREMENT VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
A	.0447	.0447	.0447	.4159

INITIAL MEAN VALUE I(OUT)MA = 5.80×10^{0}



(2) IF IN MA; IN SITU MEASUREMENT VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS				
CURVE	DOSE, kiloGy(Si)			
	.75	1.50	3.00	6.00
B	.7071	.4472	.4472	.4472

INITIAL MEAN VALUE IF(MA) = $9.34 \times 10^{+1}$

APPENDIX A

VENDOR IDENTIFICATION CODE LIST

VENDOR IDENTIFICATION CODE LIST

AVA	Avanteck, Inc.
FAS	Fairchild Semiconductor
GEC	General Electric Company
HPA	Hewlett-Packard Corporation
INL	Intersil, Inc.
MOT	Motorola, Inc., Semiconductor Products Division
OPT	Optoelectronics, Inc.
RAY	Raytheon Company
RCA	RCA Corporation, Solid State Division
SET	Semtech Corporation
SIL	Siliconix Devices, Inc.
SOD	Solitron Devices, Inc.
TIX	Texas Instruments, Inc.
TRW	TRW, Inc., Semiconductor Division
UTR	Unitrode Corporation

APPENDIX B

SEMICONDUCTOR DEVICE ELECTRICAL PARAMETER SYMBOLS AND ABBREVIATIONS

SEMICONDUCTOR DEVICE ELECTRICAL PARAMETER SYMBOLS AND ABBREVIATIONS

CAP	Diode capacitance
GM	Transconductance (FET)
GM_1/GM_2	Transconductance ratio (FET)
Cy	Gray (1 Gy = 100 rads)
h_{FE}	Common-emitter static forward current transfer ratio (gain)
I_{CBO}	Collector cutoff current open emitter
I_{CEO}	Collector cutoff current (dc) base open
I_{CER}	Collector cutoff current (dc)
$I_D(off)$	Drain cutoff current (FET)
I_{DSS}	Zero-gate-voltage drain current (FET)
I_{DSS_1}/I_{DSS_2}	Zero-gate-voltage drain current ratio (FET)
I_{GSS}	Reverse gate current (FET)
I_{GSS_1}/I_{GSS_2}	Reverse gate current ratio (FET)
I_R	Reverse leakage current, diode
NOISE	Noise voltage at specified frequency (Hz)
$R_D(on)$	Drain-source on-state resistance (FET)
$R_{EC}(on)$	Emitter-collector (on) resistance
$V_{EC}(off)$	Emitter-collector (offset) voltage
V_{GS}	Gate-source voltage (FET)
ΔV_{GS}	Radiation-induced change in gate-source voltage (FET)
V_Z	Reference voltage, diode

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